00680-90001

hp 680

680/681
682/683
STRIP CHART RECORDERS
(includes metrics)

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

GRAPHIC RECORDERS

hp 680

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 680 SERIES
STRIP CHART RECORDERS

INCLUDES 681, 682 & 683

(and metrics)

Serial Prefix: 712

433 NO. FAIR OAKS AVENUE, PASADENA, CALIFORNIA

Printed: NOVEMBER 1967

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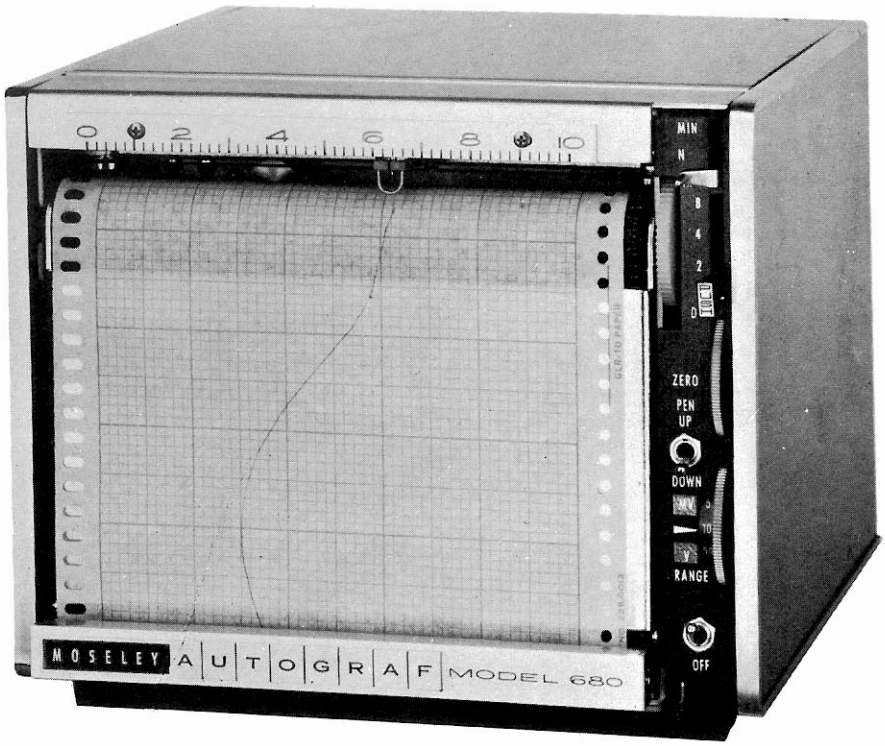


FIGURE 1-1. MODEL 680 STRIP CHART RECORDER

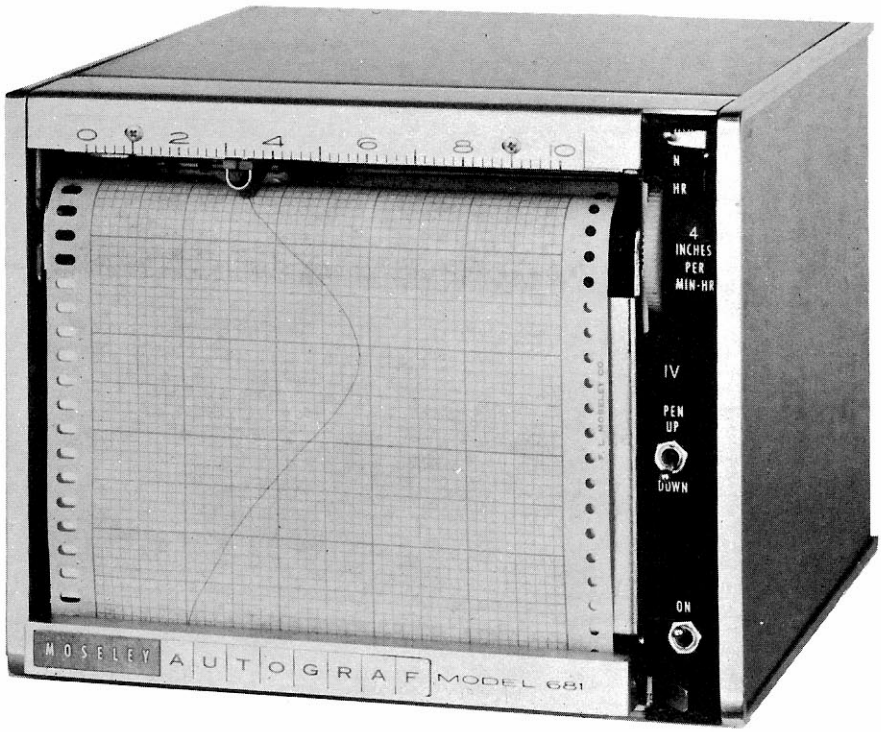


FIGURE 1-2. MODEL 681 STRIP CHART RECORDER

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION

1-2. PURPOSE AND CAPABILITY. The Moseley Model 680 Series Strip-Chart Recorders are general purpose laboratory and industrial instruments basically designed to plot cartesian coordinate graphs from DC electrical information in a rectilinear form on standard 6 inch by 100 foot chart paper with 5 inch writing width (12 cm). The physical construction of the instrument makes it readily adaptable to bench or rack mounting. Units are light weight and easily portable. All four models are available in metrically scaled and calibrated models. Available external accessories and options provide combinations to meet almost any requirement.

1-3. MANUAL IDENTIFICATION

1-4. This manual is applicable to the Model 680 Series. The models are identified by a Serial Prefix and Serial Number. The Serial Prefix is the first three digits of a two part, eight digit Serial Number (000-00000) used to identify each Hewlett-Packard instrument. If the Serial Number is higher than 712, a change sheet supplied with the manual will define the difference between that Model and the one described in this manual. Corrections to the manual, due to any errors that existed when it was printed, are called Errata, and appear only on the change sheet (if any) supplied with the manual. For information pertaining to manual coverage on any Hewlett-Packard instrument, contact the nearest Hewlett-Packard Sales/Service Office.

1-5. MODEL DIFFERENCES

1-6. This manual applies specifically to Model 680, 681, 682 and 683 Recorders. The following paragraphs describe features furnished under specific model designations:

MODEL 680. This is the most versatile recorder of the six inch strip-chart family and features 10 calibrated input spans, 8 chart speeds, continuous electronic reference, adjustable full scale zero set, and local or remote electric pen lift.

MODEL 680M. Same as the Model 680 except metrically scaled and calibrated.

MODEL 681. Similar to the Model 680 except for a single calibrated input span, and dual chart speed (in a 60 to 1 ratio).

MODEL 681M. Same as the Model 681 except metrically scaled and calibrated.

MODEL 682. This model is designed specifically for temperature recording. The recorder is supplied with one plug-in module and a customer selected single span compensated for the specified thermocouple type and reference temperature. Otherwise, it is identical to the Model 681.

MODEL 682M. Same as the Model 682 except for chart speed.

MODEL 683. This model was designed specifically as a current recorder. It has a single customer selected current span of up to a maximum full scale sensitivity of 5 micro-amperes. Other features and capabilities are the same as the Model 681.

MODEL 683M. Same as the Model 683 except metrically scaled and calibrated.

1-7. OPTIONAL FEATURES AND ACCESSORIES

1-8. The 680 Series Recorders offer many direct uses; however, the addition of accessories or exercise of options will provide a more specialized instrument for each particular application. They will also increase the utility of the recorder in a variety of functions. Metric accessories must be used on metric recorders for proper operation.

1-9. ACCESSORIES

1-10. MODEL 7560A AND 7561A LOGARITHMIC CONVERTER. Since the Model 7560A is designed to operate with a ten-inch recorder, the recorder must be factory modified to make both units compatible (see paragraph 1-21).

RECORDING MECHANISM:

INK: Servo actuated ink pen drive, free of ground, with local and remote pen lift and full scale zero adjustment.

ELECTROSENSITIVE: Similar to ink mechanism except a stylus for electrosensitive paper and the associated electronics are furnished in place of the ink pen.

CHART REQUIREMENTS:

INK: 6" by 100' roll charts, 5 inch (12 cm) writing width. Approximately 4" by 6" visible chart area during operation.

ELECTROSENSITIVE: 6" by 80' roll charts, 5" (12 cm) writing width.

RESPONSE TIME: One-half second or less for full scale.

CHART SPEEDS:

MODEL 680: Eight synchronous motor controlled speeds at 1, 2, 4, 8 inches per minute; 1, 2, 4, 8 inches per hour. Metric model: 2.5, 5, 10, 20 centimeters per minute; 2.5, 5, 10, 20 centimeters per hour.

MODEL 681, 682, 683: Two speeds in a 60 to 1 ratio as selected. Generally any speed up to 8 inches per minute (20 cm/minute on metric models) may be specified.
Other speeds in a ratio of 16 to 1 may be supplied on all models.

SPANS:

MODEL 680: Ten calibrated spans of 5, 10, 50, 100, 500 millivolts; 1, 5, 10, 50, and 100 volts, full scale. Metric model has spans of 6, 12, 60, 120, and 600 millivolts; 1.2, 6, 12, 60, and 120 volts. An extra span of 1 millivolt, full scale, (1.2 millivolt on metric models) is available.

MODEL 681: Choice of a single full scale voltage span of essentially any value between 5 millivolts and 120 volts. Spans down to 1 millivolt may be ordered.

MODEL 682: Single selected temperature span. Thermocouple type and reference junction temperature must be specified when ordering.

MODEL 683: Choice of a single current span up to a maximum full scale sensitivity of 5 micro-amperes.

INPUT RESISTANCE:

MODEL 680, 681: 200,000 ohms per volt (166, 166 ohms/volt on metric models) full scale, through 10 volt span; 2 megohms on all others. Potentiometric input on most sensitive span permits operation with essentially zero current drain at null. Constant 100,000 ohm input resistance on all spans (except 1 millivolt and 1.2 millivolt models) available on both models.

MODEL 682: True potentiometric input drawing essentially zero current from signal at null.

MODEL 683: Input resistance dependent on current span selected. Standard model has basic sensitivity of 5 micro-amperes and 1000 ohms resistance, full scale (6 micro-amperes, metric model).

STANDARDIZATION:

Continuous electronic reference from zener diode controlled power supply. Calibration of Model 682 is in accordance with National Bureau of Standards circular 561 (1955), "STANDARD REFERENCE TABLES FOR THERMOCOUPLES".

ZERO SET:

MODEL 680: Continuously adjustable over full recorder span.

MODEL 681, 683: Adjustable by internal control. Unless otherwise specified, control will be factory set for zero-left operation.

ACCURACY:

Better than 0.2% of full scale with 0.1% of full scale resettability.

INTERFERENCE REJECTION:

DC common mode rejection better than 100,000 to 1 on 5 millivolt span.

POWER REQUIREMENTS:

115/230 volts, 60 cps, 22 volt-amperes.
50 cps models available at extra cost.

PHYSICAL DIMENSIONS:

6-3/32" high, 8" deep, 7-3/4" wide, approximately 10 pounds. Rack mounting requires 7 inches of vertical space.

FIGURE 1-3. SPECIFICATIONS

1-11. DUAL RACK ADAPTER, P/N A-15448. This accessory allows a 680 Recorder to be rack mounted in a standard 19" console. It will accept two 680 Recorders (side by side) or a 680 and any similar size H-P modular package, such as the F-3B.

NOTE: This rack adapter cannot be used with Option-14 (glass door).

1-12. DUAL RACK ADAPTER WITH GLASS FRONT, P/N M-18710. This accessory provides the same features as the preceding adapter, with the added feature of two individual locking glass doors. A single glass door mounted on the dual rack adapter and a removal blank panel is also available, P/N M-18709.

1-13. OPTIONS

1-14. RETRANSMITTING POTENTIOMETER (Option -01). 5K ohm potentiometer coupled to the recorder servo drive allows operation as a process controller, stable DC amplifier, or DC to AC converter with output of most any frequency or waveform desired (field installation).

1-15. EVENT MARKER (Option -02). Continuous recording Event Marker identifies significant points in the recording sequence by an inked trace at the right-hand margin of the graph paper. It is remotely actuated by a simple contact closure (factory installed).

1-16. LIMIT SWITCHES (Option -03). Adjustable over the full recording span, they provide a contact closure for remote control or indication of operational limits. Two switches may be installed, one for each margin (field installation).

1-17. 16 TO 1 SPEED REDUCER (Option -08). Replaces the normal 60 to 1 speed reduction ratio.

1-18. REMOTE CHART DRIVE SWITCH (Option -09). This switch allows the chart motor to be turned off by an external circuit in unattended operation. A variety of other uses is also possible.

1-19. 50 CPS OPERATION (Option -10). Special synchronous chart drive motor permits operation from 50 eps line source.

1-20. SPECIAL SCALE MARKINGS (Option -11). This option generally applies to a customer with a specific operation for the recorder, i.e., if measurement of light waves, tensile strength, etc. is to be made continuously, the scale can be marked in corresponding units of measure.

1-21. OPERATION WITH LOGARITHMIC CONVERTER (Option -13). A factory modification to the recorder to allow direct compatibility with the Logarithmic Converters, 7560A and 7561A.

1-22. LOCKING GLASS DOOR (Option -14). The door provides a means of preventing tampering with the recorder controls as well as offering a dust proof case. Recorder may be wall mounted or operated as a bench top instrument. Refer to figure 1-6 for illustration and installation of drawing (field installation).

1-23. ELECTRO SENSITIVE RECORDING (Option -15). Provides a crisp, clean, permanent record by means of an electrical stylus which replaces the ink pen. Special paper is required (factory installation).

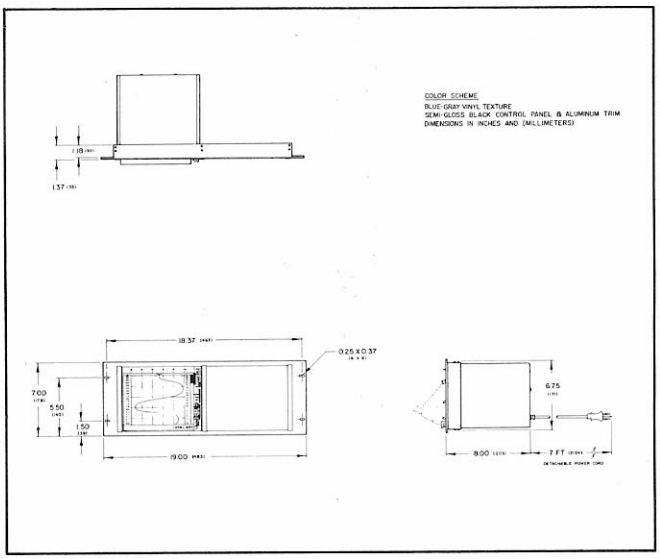


FIGURE 1-4. DUAL RACK ADAPTER A15448

1-24. ELECTRIC WRITING EVENT MARKER (Option -16). This event marker is used when electro sensitive paper is used. It can only be used in conjunction with option -15. Crisp, clean, permanent traces synonymous with option -15 are also provided by the event marker.

1-25. PHOTO-SLIDEWIRE (Option -17). This option replaces the standard wirewound mandrel and contacting wiper with a unique non-contacting balance potentiometer. The elimination of the contacting wiper eliminates cleaning and wear while increasing reliability and dependability. This option is not available on H01-680 and H01-680M.

1-26. DISPOSABLE PEN TIPS (Option -18). This option provides a pen using disposable pen tips. Both fiber pen tips (general and fast speeds) and molded capillary pen tips (slow speeds) are available. The clog resistant tip provides non-skip writing and eliminates critical pen alignment. Worn pen tips may be quickly replaced.

1-27. SPECIAL MODELS

1-28. ONE MILLIVOLT FULL SCALE SENSITIVITY. (1.2 mv f.s. on metric models.) For applications where unusually small input signal voltages must be recorded. Provides 0.5% full scale accuracy. Model numbers are prefixed by H01- on serial tag.

1-29. HIGH INPUT RESISTANCE. 100,000 ohms input resistance on all standard ranges; allows operation with minimum current drain from signal source. Model numbers are prefixed by H02- on serial tag.

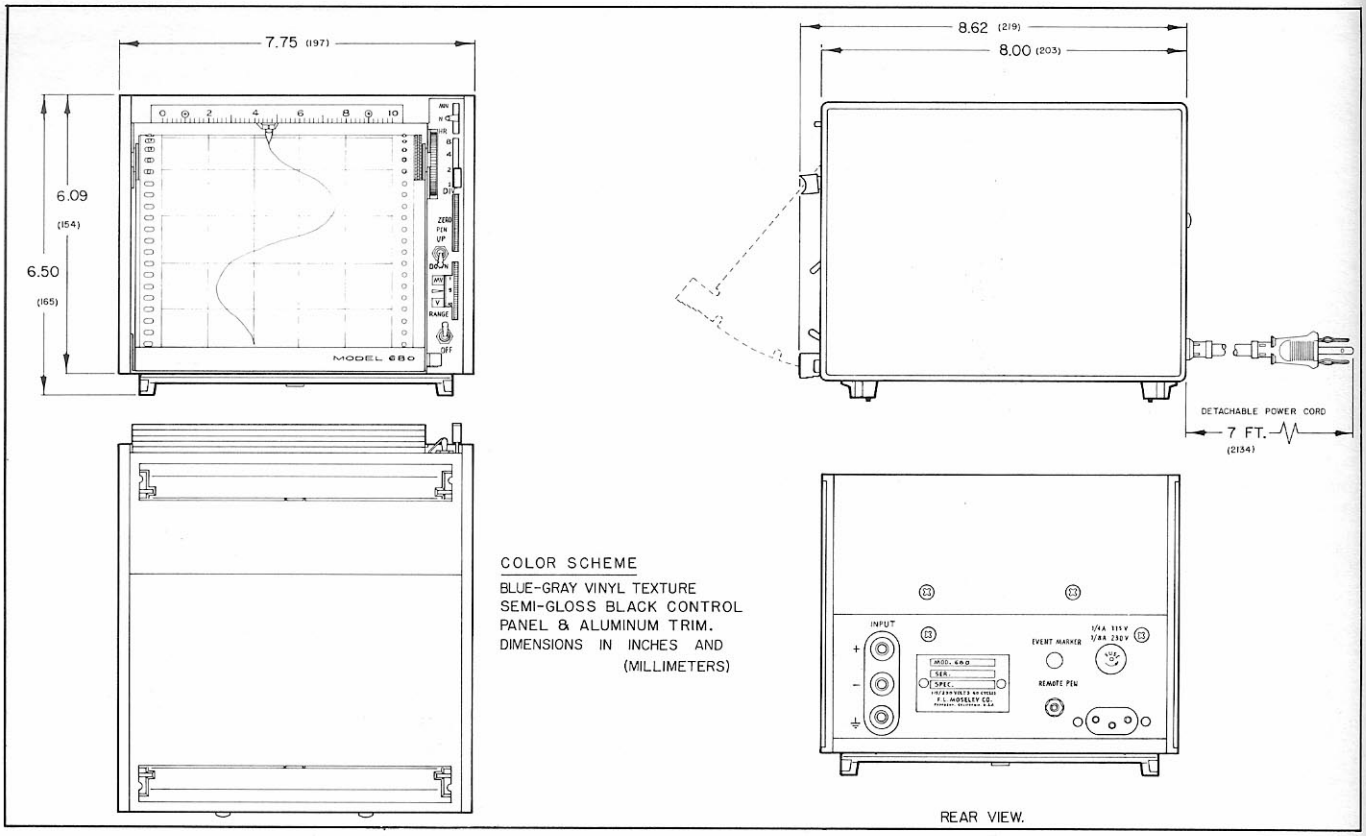


FIGURE 1-5. PHYSICAL DIMENSIONS

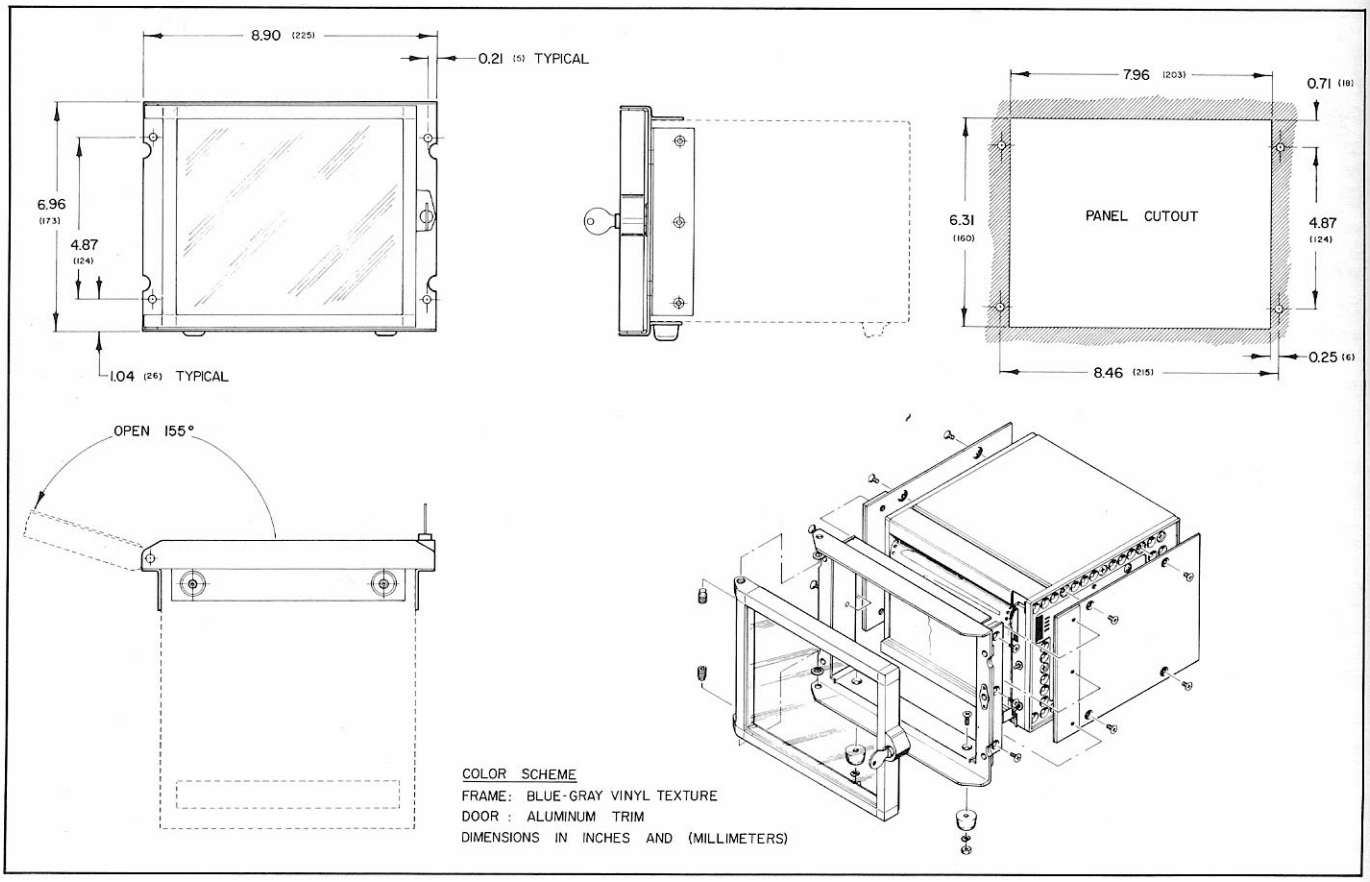


FIGURE 1-6. DIMENSION DRAWING OF DOOR ADAPTER (OPTION 14)

SECTION II
INSTALLATION AND INSPECTION

2-1. INTRODUCTION

2-2. This section supplies information on incoming inspection, installation of recorder options, installation of recorders, storage, and shipping.

2-3. INCOMING INSPECTION

2-4. MECHANICAL CHECK. If damage to the shipping carton is evident ask that the carrier's agent be present when the instrument is unpacked. Inspect for mechanical damage, scratches, dents, broken knobs, etc. Also check for evidence of severe stress in the cushioning material.

2-5. PERFORMANCE TESTS. The electrical performance should be verified as soon as possible after receipt. Use performance inspection chart, figure 2-1.

REQUIRED INSTRUMENTS

a. Stop watch

b. DC Standard 1 volt - 50 mv - 50 volts

c. Ohmmeter - 0-2 megohm range

1. Remove top cover and make sure 115/230 selector switch is correctly set at 115 volts. If 230 volts is the only available power source, set the selector to 230. Before applying power, check the fuse for proper value. A 1/4 ampere fuse is required for 115 volt operation and 1/8 ampere fuse for 230 volts.

2. Apply power to the recorder.

3. Check the remote pen and event marker plugs (if so equipped) for proper operation. This simply requires the closing of the two contacts.

4. CHART SPEED. A check of the chart speed varies with the model being inspected. On the Model 680 set the DIV control to the MIN position and set the gear train control to 1 div. Run for 3 minutes at these settings using a stop watch for accurate timing. The line produced should be 3 divisions long.
Set the DIV control to HR and the gear train control to 8 divisions. Run for 15 minutes, again using a stop watch. The line produced should be 2 divisions long.
The same method is used on the other models in the series; however, they have only two speeds in a ratio of 60 to 1. Duration of time and length of line are dependent variables and must be calculated for the particular instrument tested.

NOTE: General operation procedures in Section III include installation of ink cartridges, chart paper, along with a complete listing of the functions of the control panel.

5. CALIBRATION. Similar to step 3 for chart speeds, calibration checks vary slightly with different models. The following checks are for the Model 680. Set the RANGE selector at 1 volt and position the pen at the zero mark. Apply a + 1 volt DC signal to the inputs for full scale deflection. Refer to Section I for specifications and tolerances.

FIGURE 2-1. PERFORMANCE INSPECTION CHART (Sheet 1 of 2)

A similar check should be made for the 50 mv and 50 volt ranges. Apply the required voltage for full scale deflection.

6. LINEARITY may be checked in a manner similar to that used in calibration except that a stepped input is employed. With the pen at "0" apply 10 steps of 0.1 volts each . (1.093 volts for metric recorders in 12 steps.) Each step should line up with the major vertical divisions.

7. INPUT RESISTANCE. This may be checked at the input terminals with an ohm meter. A table of correct values is provided in Section III (figure 3-1).

FIGURE 2-1. PERFORMANCE INSPECTION CHART (Sheet 2 of 2)

2-6. CLAIM FOR DAMAGE. In case of mechanical damage or failure to meet specifications during performance tests, notify the carrier and nearest Hewlett-Packard field office immediately. Refer to listing in rear of this manual. Retain shipping carton and padding material for inspection by carrier. Arrangements will be made by the field office for repair or replacement of your instrument without waiting for settlement of a claim against the carrier.

2-7. STORAGE

2-8. If the instrument is to be stored for a period of time, the ink line should be flushed. The pen should be secured to the side of the instrument to prevent damage during handling. Seal the instrument in a moisture proof covering and repackage the unit in a container similar to the original factory one.

2-9. SHIPPING

2-10. Before returning instrument for any reason, notify the nearest field sales office of the difficulty encountered giving the model and serial number. They will provide shipping instructions. Prepare instrument for shipping in the manner outlined for storage, being careful to surround with at least three to four inches of shock-absorbing material to cushion and prevent movement inside container.

2-11. INSTALLATION

2-12. The 680 is a bench mounting recorder and require no physical installation. Rack mounting accessories are designed for installation in a standard 19 inch rack and require 7 inches of vertical space.

2-13. COOLING. Location or mounting should be chosen to insure sufficient circulation of air to cool by convection. No forced air cooling is provided.

2-14. INSTALLATION OF OPTIONS

2-15. GENERAL. All Model 680 Series recorders may be equipped with optional accessories which increase the versatility and application to special operating requirements. Many of these are described in paragraph 1-7. Some require factory installation while others are available in kit form. Sufficient information is presented in this section for customer installation of those available in kit form.

2-16. OPTIONS AVAILABLE FOR FIELD INSTALLATION. Kits may be secured for the installation of the following accessories:

a. Retransmitting Potentiometer (A10953)

b. Limit Switches (A10825)

NOTE: A mounting hole and adequate space are provided in the top rear of the recorder for acceptance of these accessories. See figure 2-2.

2-17. INSTALLATION OF RETRANSMITTING POTENTIOMETER. A three-turn 5K potentiometer may be connected to the drive shaft of the motor drive unit. The potentiometer is customer selected to provide the resistance range and linearity required by the particular application. To install:

a. Remove top cover from the recorder to expose the motor drive unit.

b. Place a flexible extension on the potentiometer shaft and insert the assembly from the rear of the recorder through the existing hole directly behind and in line with the drive shaft of the motor unit. While inserting, slip lock washer and nut over extension after it reaches opposite side of chassis.

c. Guide end of extension to mate with motor drive shaft.

d. Fasten the potentiometer to the recorder chassis with the mounting lock washer and nut.

e. Adjust the potentiometer travel limits to agree with the recorder full scale travel limits.

f. Tighten all set screws.

2-18. INSTALLATION OF LIMIT SWITCHES. The limit switch assembly supplied in kit form is installed in a manner identical to that used for the retransmitting potentiometer. (See paragraph 2-17.) After installation, operational adjustment should be made as follows:

a. Loosen the locking set screws.

b. Move the recorder zero control so that the pen is positioned at the desired high limit.

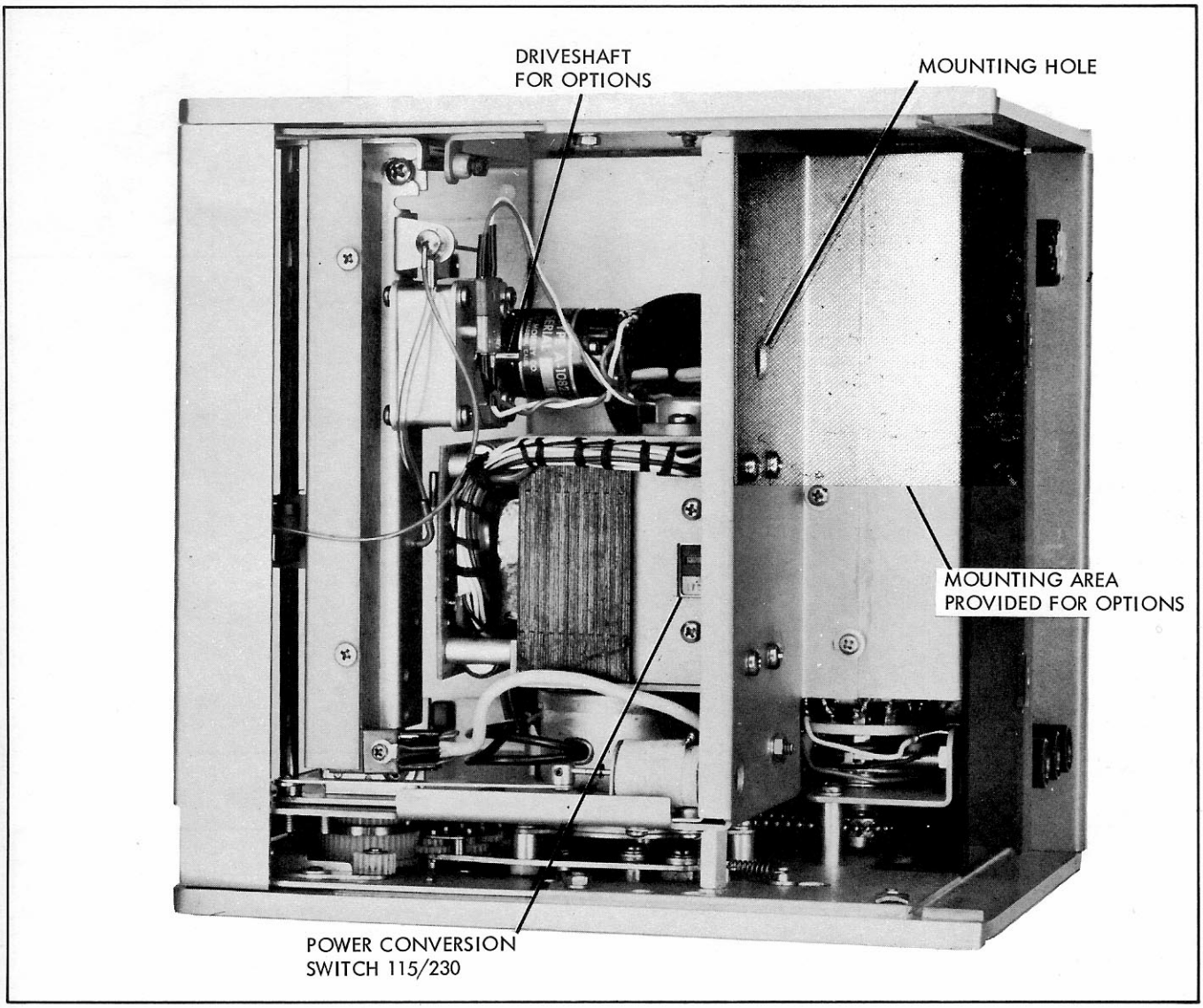


FIGURE 2-2. TOP VIEW OF RECORDER

c. Move the inner dial so that the high limit switch is closed. Tighten the set screw.

d. Position the recorder pen for the low limit.

e. Move the outer dial so that the low limit switch is closed. Tighten the set screw.

f. Verify the settings by operating the recorder and noting the resulting contact closures as the pen traverses the scale. Readjust, if necessary.

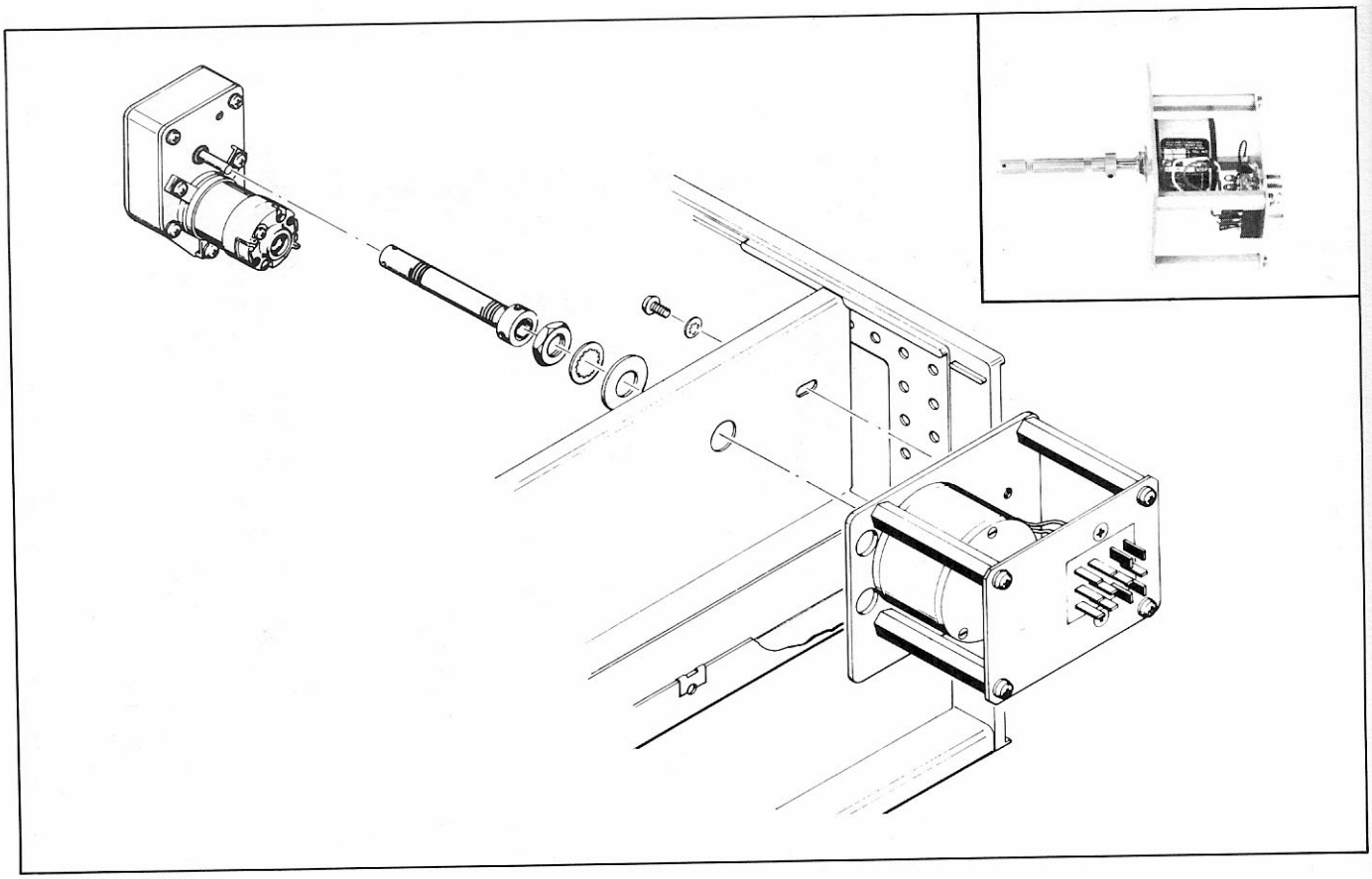


FIGURE 2-3. RETRANSMITTING POTENTIOMETER INSTALLATION

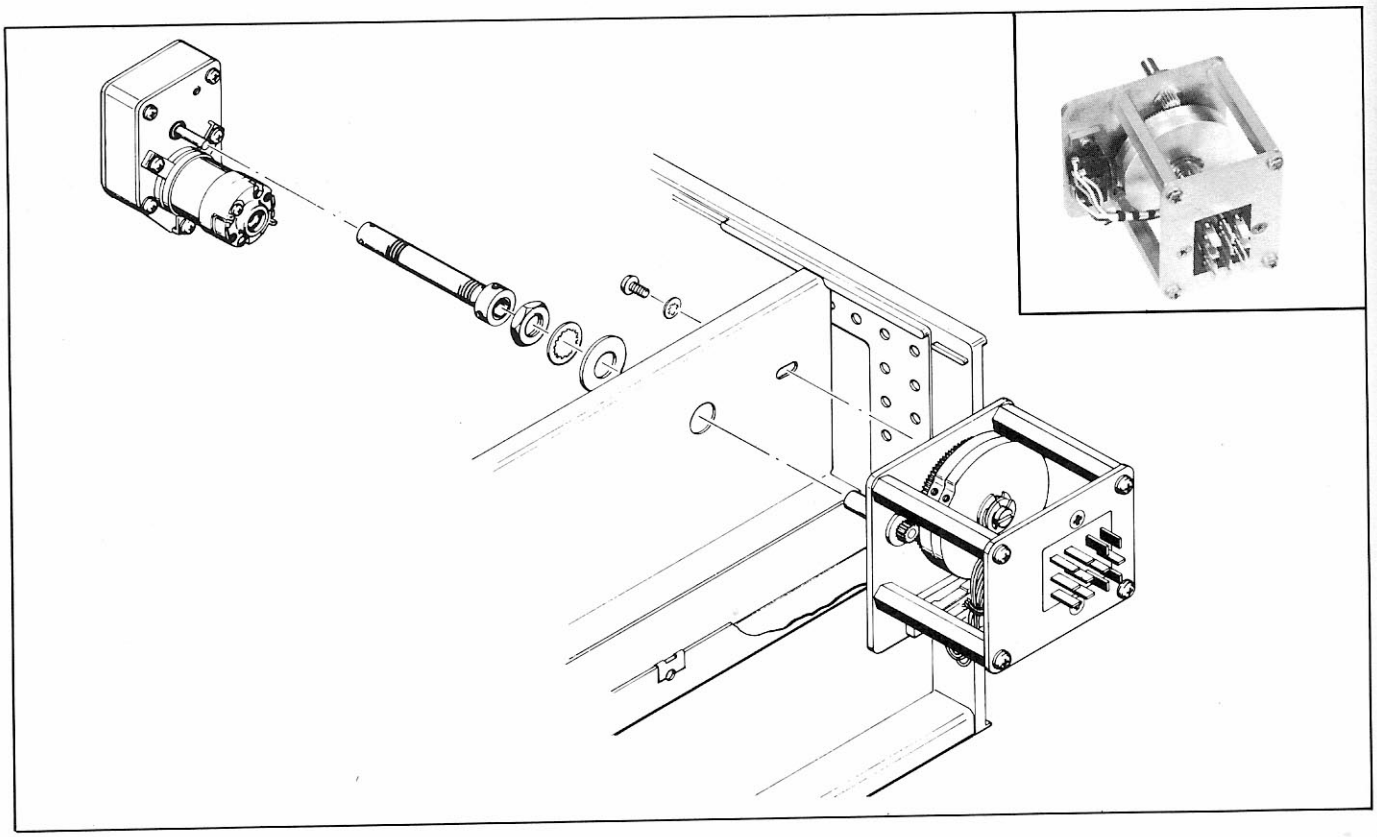


FIGURE 2-4. LIMIT SWITCH INSTALLATION

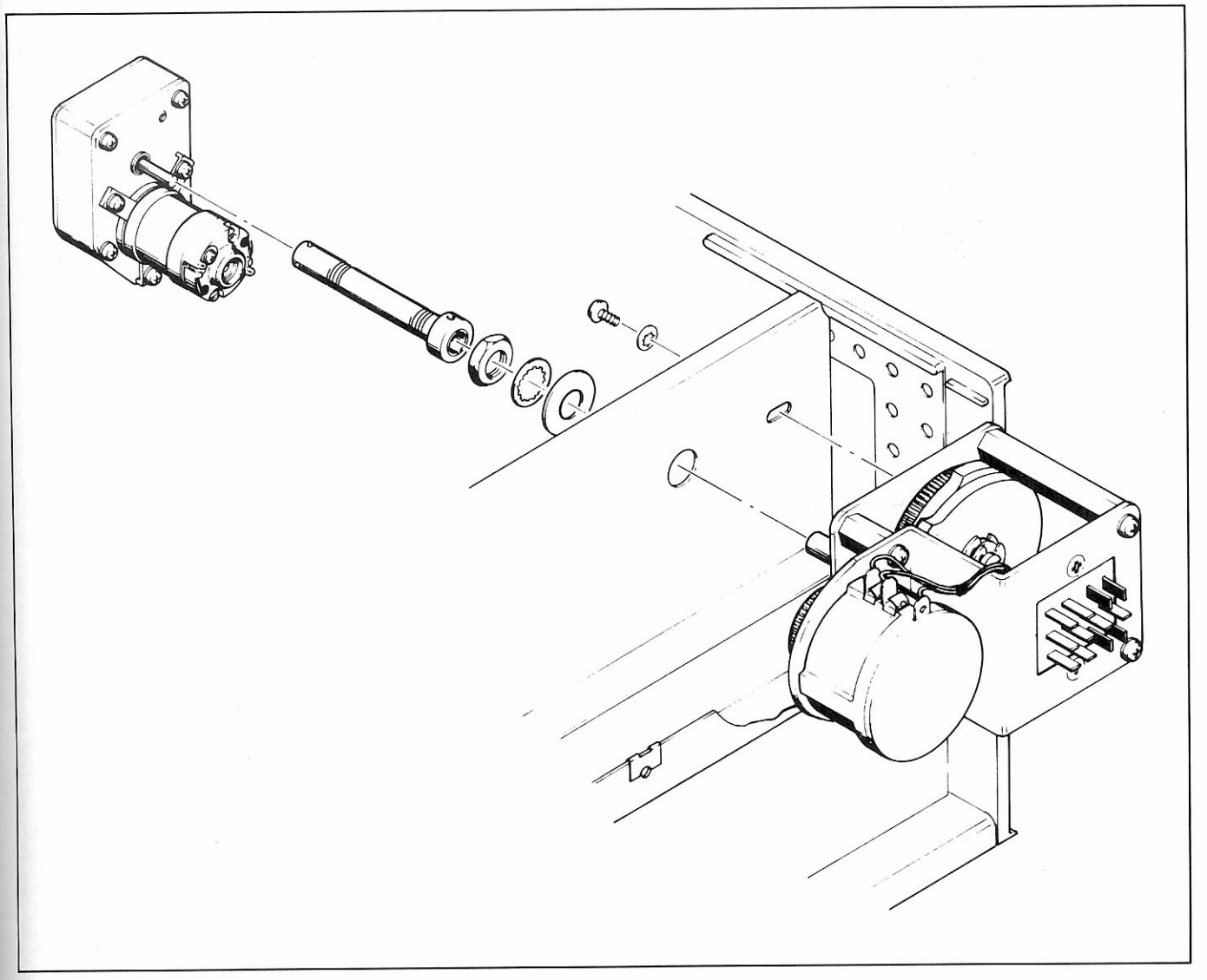


FIGURE 2-5. LIMIT SWITCH AND RETRANSMITTING POTENTIOMETER INSTALLATION

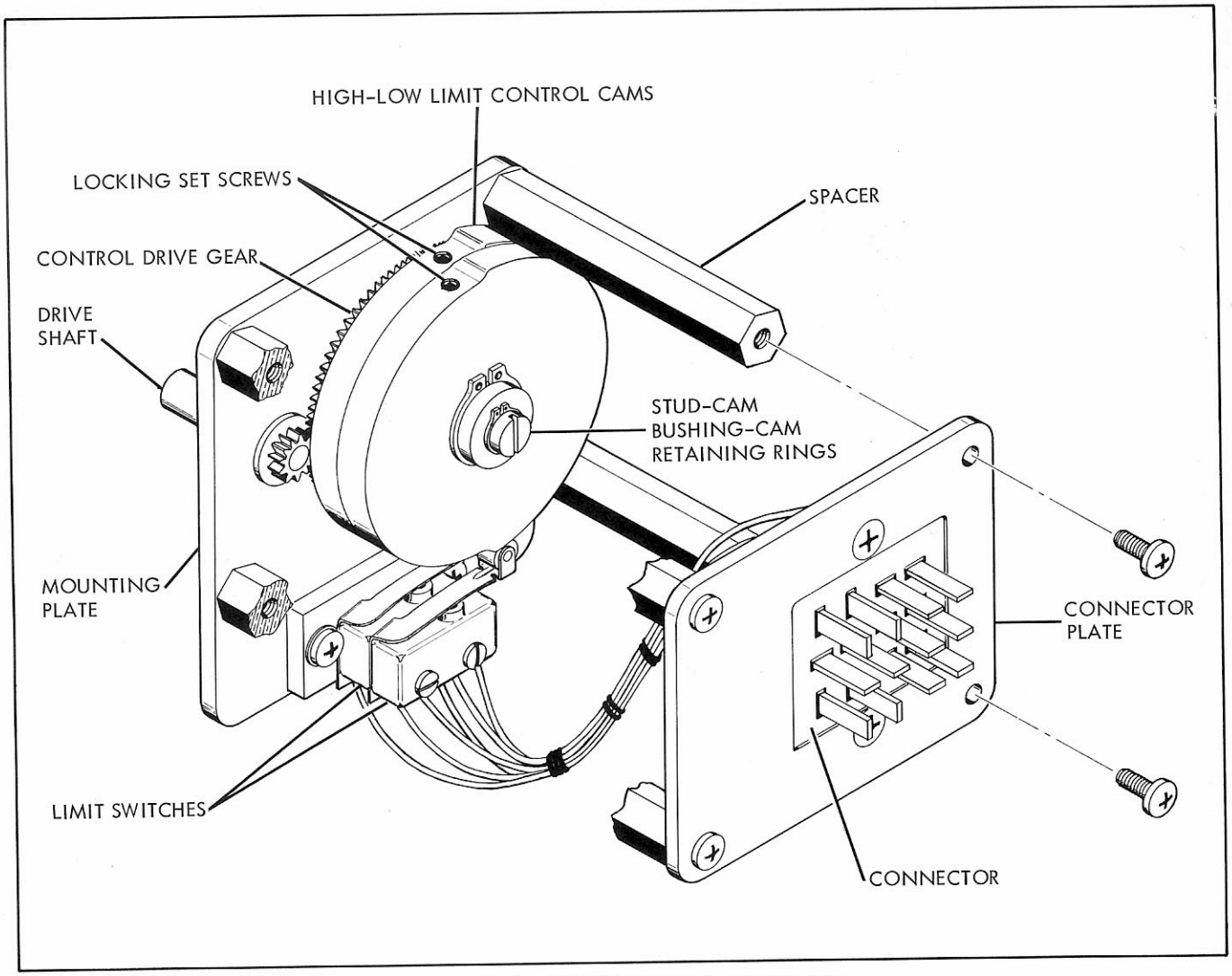


FIGURE 2-6. LIMIT SWITCH ASSEMBLY

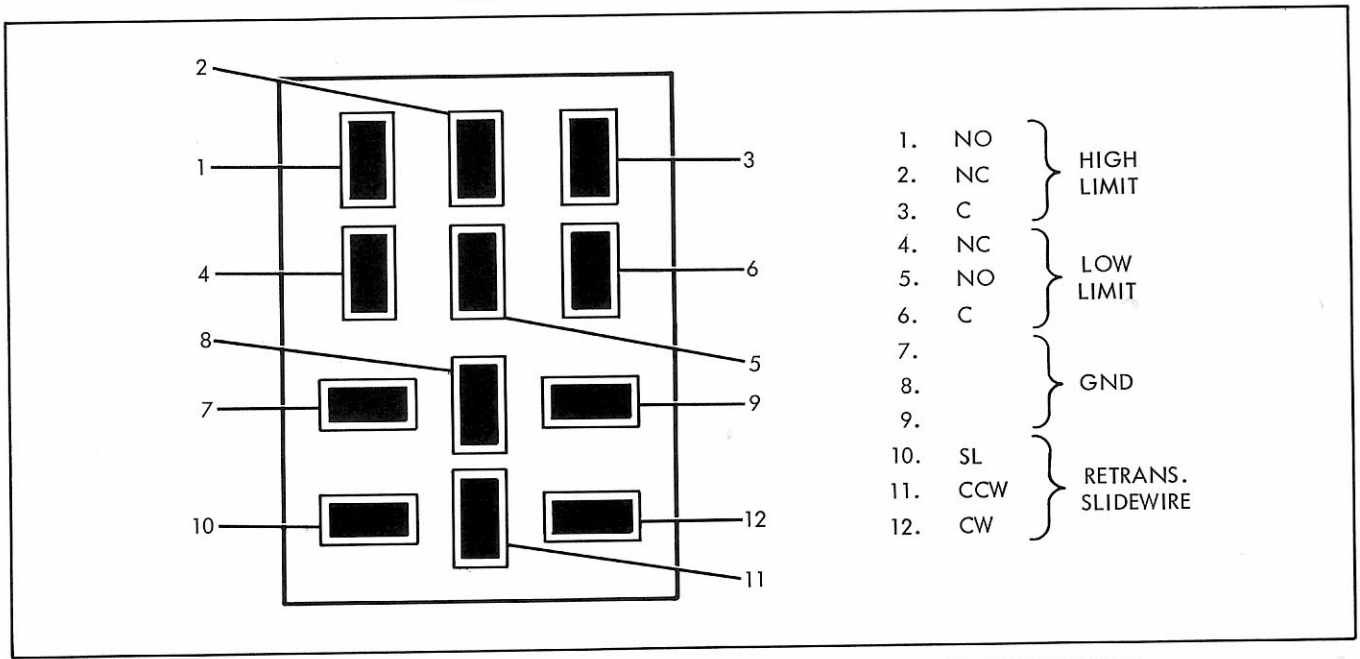


FIGURE 2-7. PIN ASSIGNMENT OF OPTIONAL EQUIPMENT CONNECTOR

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION

3-2. The Model 680 series recorders are compact instruments designed to produce graphs showing the relationship between a variable function and time. An electrical signal representing the function is applied to the input terminals and the recorder controls adjusted so that the resulting graph will cover the desired scope of operation. The Model 680 is designed for general purpose recording, 681 for single range voltage recordings, 682 for temperature recordings, and the Model 683 for current recordings. Before operating, the user should become familiar with the input requirements and various control functions as outlined in the following paragraphs.

3-3. ELECTRICAL REQUIREMENTS

3-4. OPERATING POWER. Standard recorders are designed for 115/230 volts, 60 cps operation. Fifty (50) cps operation is available on special models. A power conversion switch, located on the top of the instrument next to the transformer, (access requires removal of top cover) must be set to correspond to the available line voltage.

CAUTION: For optimum performance, the third prong of the AC power cord must be grounded. Grounding may also be accomplished by connecting the signal ground terminal to ground. Proper grounding has proven to be mandatory when operating from 230 volt power supplies, or from ungrounded power systems.

3-5. INPUT DATA SIGNALS. The recorder input terminals must be supplied with DC signals which are accurate functions of the original information. These signals must vary at a rate within the response capabilities of the instrument (1/2 second full scale), and have amplitudes within its scale ranges.

CAUTION: Do not exceed 120 volts inputs.

3-6. INPUT CONNECTIONS. The input terminals located on the rear of the instrument accept either open wires or banana type plugs. This type of terminal is standard on all models except the 682 which is equipped with a terminal strip.

3-7. OPERATING CONTROLS (Refer to figure 3-2)

3-8. POWER SWITCH. The power switch controls instrument power. Its two positions are ON and OFF.

3-9. RANGE SELECTOR. (Model 680 only.) The scale positions are calibrated in volts or millivolts for full scale spans. The volts and millivolts spans are color coded with the coding clearly indicated next to the Range Selector.

CAUTION: Input potentials should never exceed 100 volts on the Model 680 and 120 volts on all other models (or full scale span).

3-10. PEN SWITCH. The pen switch controls the raising and lowering of the pen or stylus. In the UP position the pen is raised and in the DOWN position it is lowered. The raising and lowering of the optional event marker pen is also controlled by this switch.

3-11. ZERO CONTROL. A potentiometer permits placement of electrical zero anywhere on the graph. This control is adjusted externally on the Model 680. Models 681 and 683 have an internally adjusted potentiometer which is accessible by removing the bottom cover of the recorder. The screw adjustment is set for zero-left operation at the factory but may be readjusted with a common tip screwdriver. The Model 682 is not equipped with a zero control.

3-12. DIVISION CONTROL. (Model 680 only.) Designated "DIV". This lever allows selection of the chart speeds in divisions per minute or per hour,

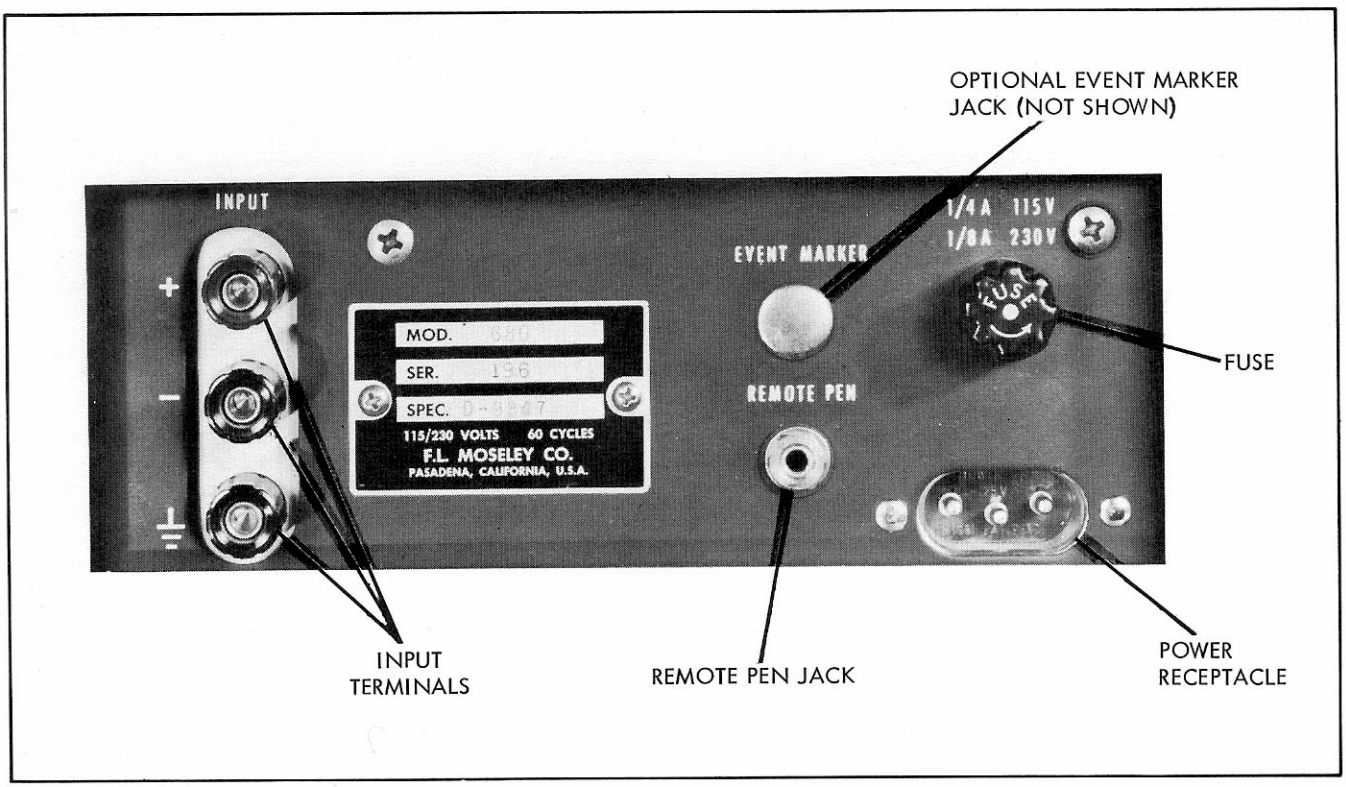


FIGURE 3-1. REAR PANEL

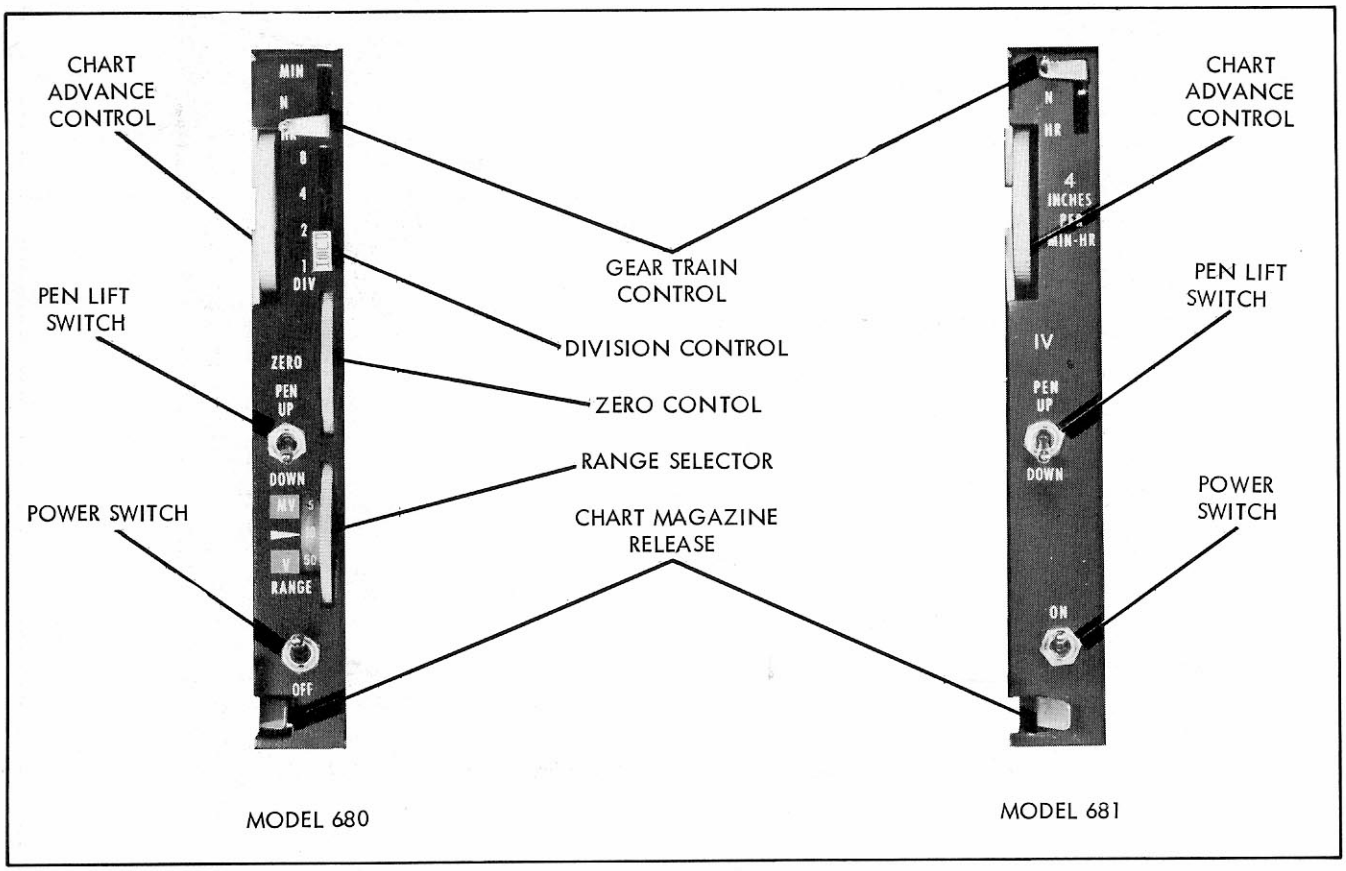


FIGURE 3-2. CONTROL PANELS OF MODEL 680 & 681

determined by the position of the gear train control. The four standard positions are 1, 2, 4, 8.

3-13. GEAR TRAIN CONTROL. This lever selects a 1:1 or 60:1 gear ratio. Thus when used on the Model 680 in conjunction with the Division Control in the MIN position (1:1 ratio) 1, 2, 4, and 8 are in inches or 2.5, 5, 10, and 20 centimeters per minute and when in the HR position (60:1 ratio) the divisions are in inches or centimeters per hour. All other models have this control but only one basic speed. A second speed is provided through the 60:1 ratio. The three positions of this lever are as follows:

1. "MIN" Chart will advance in inches or centimeters per minute. This is in a 1:1 ratio or direct drive coupling.

2. "N" Chart will stop. The neutral setting engages a clutch assembly which allows the chart drive motor to continue to rotate but disengages it from the chart drive.

3. "HR" Chart will advance in inches or centimeters per hour. This is in a 60:1 ratio drive.

3-14. MANUAL CHART CONTROL. With the gear train control set at "N" the manual chart control can be used to advance the chart manually.

3-15. CHART LATCH. Depression of the chart latch allows the magazine to be set in anyone of its three operating positions or to allow complete removal.

3-16. REMOTE PEN CONTROL. Remote pen control is available through a connector on the rear of the instrument. Connection of a contact closure across the connector terminals will cause the pen to lower. The raising and lowering of the optional event marker is by remote control.

3-17. REMOTE CHART DRIVE CONTROL (OPTIONAL). When furnished, remote chart drive control is obtained through a connector on the rear of

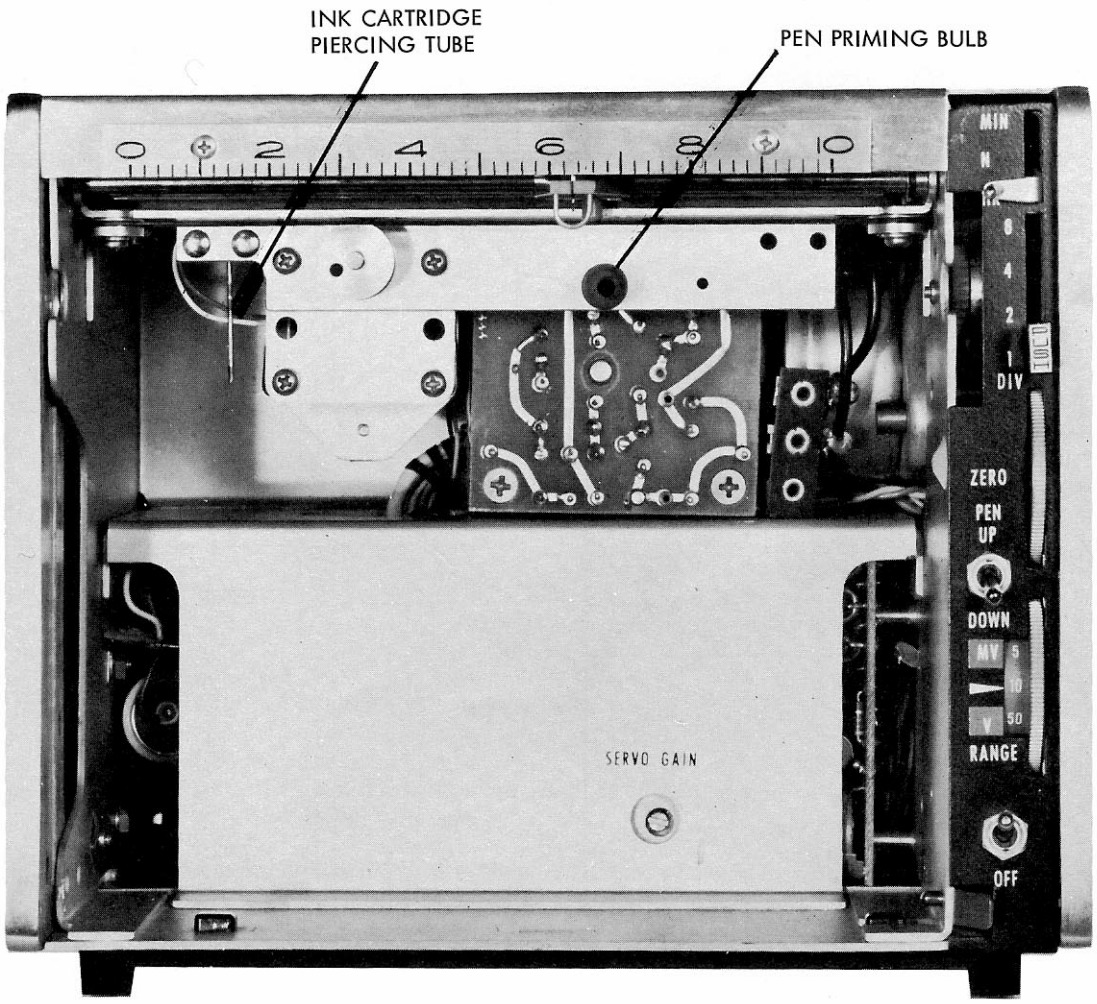


FIGURE 3-3. MODEL 680 WITH CHART MAGAZINE REMOVED

the instrument. A contact closure connected across the connector terminals will initiate the chart drive motor.

3-18. EVENT MARKER (OPTIONAL). When furnished, the connector for the event marker is mounted on the rear of the instrument. A contact closure connected across the connector terminals will initiate the event marks. Raising and lowering of the event marker pen or stylus is controlled by the main pen switch.

3-19. OPERATION PROCEDURE

3-20. CONDITIONS OF OPERATION. For satisfactory operation the applied input signal must be DC, the available voltage being an accurate function of the original information. Amplitudes of the signal must be within the scale ranges and vary in level at a rate within the response capabilities of the instrument (see paragraph 3-5).

Span	Input Resistance (ohms/volt)	Full Scale Current Drain (micro-amperes)	Input Resistance (ohms)
5 mv	200,000	5	1,000
10 mv	200,000	5	2,000
50 mv	200,000	5	10,000
100 mv	200,000	5	20,000
500 mv	200,000	5	100,000
1 volts	200,000	5	200,000
5 volts	200,000	5	1,000,000
10 volts	200,000	5	2,000,000
50 volts	40,000	25	2,000,000
100 volts	20,000	50	2,000,000
ENGLISH SCALED MODEL 680			
Span	Input Resistance (ohms/volt)	Full Scale Current Drain (micro-amperes)	Input Resistance (ohms)
6 mv	166,667	6	1,000
12 mv	166,667	6	2,000
60 mv	166,667	6	10,000
120 mv	166,667	6	20,000
600 mv	166,667	6	100,000
1.2 volts	166,667	6	200,000
6 volts	166,667	6	1,000,000
12 volts	166,667	6	2,000,000
60 volts	33,333	30	2,000,000
120 volts	16,667	60	2,000,000
METRIC SCALED MODEL 680			

FIGURE 3-4. INPUT CHART

3-21. OPERATION. Provided the signal requirements are satisfied, the recorder may be placed into operation as follows:

a. Place the power switch ON.

b. Install ink cartridge. Depress the lever which is adjacent to the power switch at the bottom of the control panel, raise the chart magazine to a horizontal position and slide it from the recorder. Force the cartridge over the piercing tube of the corresponding pen and screw all the way on. The piercing tubes (up to two) are located in the same plane as the pen. See figure 3-3. Pen primers are located behind the chart magazine and just below the pen. Depressing the primer will force ink from the cartridge to the pen tip.

c. Load paper. Before replacing chart magazine install a roll of 6" width graph paper as follows: (Refer to figure 3-5)

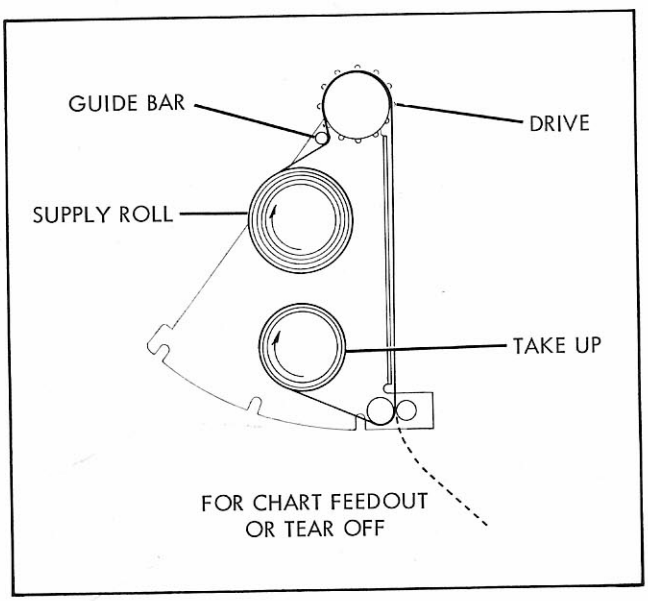


FIGURE 3-5. CHART LOADING DIAGRAM

(1) Position the empty chart magazine as indicated in figure 3-5.

(2) Insert the supply roll between the upper spring loaded hubs with the elongated drive holes of the paper to the right.

(3) Thread paper from the new supply roll under the guide bar.

(4) Bring the paper over the top of the sprocket drive drum and engage the sprockets.

(5) Pull the paper down across the face of the chart magazine and feed through the slot at the bottom of the platen.

(6) Rotate the drive gear so that the paper will feed through the slot.

(7) The paper will now feed out through the bottom of the chart magazine and may be torn off as the operator desires. If this type of operation is desired, the chart paper magazine may be installed in the recorder. For operation with the chart stored on a take-up spool within the chart magazine, continue with steps 8 and 9.

(8) Install an empty takeup spool (supplied) between the two lower hubs. Index the left end of the spool so the drive stud on the left hub mates with the slot on the takeup spool.

(9) Attach the end of the chart paper on the takeup spool with adhesive tape. Rotate the drive gear until several turns of paper are on the take-up spool. Inspect for proper chart tracking without buckling and then install the chart magazine.

d. When applicable, set the scale range to the expected maximum value. Connect the input signal to the input terminals.

e. The servo system should respond to the input signal. Adjust the range and zero controls on the models so equipped, to position the graph on the chart prior to actual recording.

f. Set the chart speed selector to the desired speed and actuate the drive motors.

g. Set the pen switch to DOWN.

3-22. OPERATING PRECAUTIONS

3-23. Voltages in excess of the range setting (Model 680) or maximum scale voltage will drive the pen against the full scale stops. If this is allowed to continue, a slip clutch will permit the motor to run causing excessive clutch wear, motor overheating, and possible component failure.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL OPERATION DESCRIPTION

4-2. SERVO MECHANISM. The Models 680, 681, 682, and 683 strip chart recorders use a single isolated self-balancing servo-mechanism to move the pen, and a multi-speed motor drive to advance the chart. The pen moves at right angles to the direction of paper travel in response to applied input signals. The relative motion of pen and chart results in a plotted graph of function versus time.

4-3. RANGE CONTROL (Model 680 only). The basic voltage range of the servo system for the Model 680 is 5 millivolts full scale. Operation with greater voltages is obtained by switching precision resistors into the balancing circuit. In operation, the initial range setting is based on the expected maximum voltages. Included in the input circuit is a filter which minimizes undesirable noise and ripple disturbances in the input signals.

4-4. BALANCING ACTION. After passing through the attenuator, the input signal is applied to the balance circuit where it is cancelled by an internally supplied opposing voltage. Under these conditions, there is no signal output from the balance circuit and the servo system is at null. When the input signal changes value, an unbalanced condition exists. The error signal (voltage difference) is applied to a chopper which converts the DC to a 60 cycle AC form. This is amplified and applied to the control winding of a servo motor. Because the motor and rebalance potentiometer are mechanically coupled, the balance voltage changes value until the new input signal is cancelled. If the input data is constantly varying at rates within the capabilities of the instrument, this rebalancing action is continuous and the rebalance potentiometer and pen or stylus are always in a position directly proportional to the amplitude of the signal at the input terminal.

4-5. CIRCUITRY DIFFERENCES BETWEEN MODELS

4-6. Although the Models 680, 681, 682, and 683 recorders are similar, the different functions performed by each require individual distinct circuit treatment. Each will be explained separately. Description of the 100K and 1MV Specials will also be found in this section.

MODEL 680, 680M -CIRCUIT DESCRIPTION

4-7. Circuit description and symbols apply to both instruments. Refer to schematic in section seven.

4-8. INPUT CIRCUIT. Input terminals mounted on the rear of the recorder are connected to a precision voltage divider which determines the maximum allowable input voltage. The input attenuator consists of four precision ±0.1% wirewound resistors R-101 through R-109. These resistors are located in the lower rear portion of the chart drive and control section. With the range switch in the first position, the input voltage is applied across 1K ohms, R-111, and goes directly to the balance circuit with no attenuation. The voltage in the balance loop allows a signal up to 5 millivolts full scale to be applied to the balance circuit without prior attenuation when the range switch is set to the first range (5 millivolts). Input signals greater than this must be attenuated before reaching the balance circuit. To obtain higher voltage ranges, resistance is inserted in series with R-111 (1K) up to the 10 volt range. Beyond this range R-108 or R-109 is connected in parallel with R-111 thus decreasing the resistance applied at the 10 volt position.

4-9. POTENTIOMETRIC INPUT. This mode of operation provides maximum sensitivity with

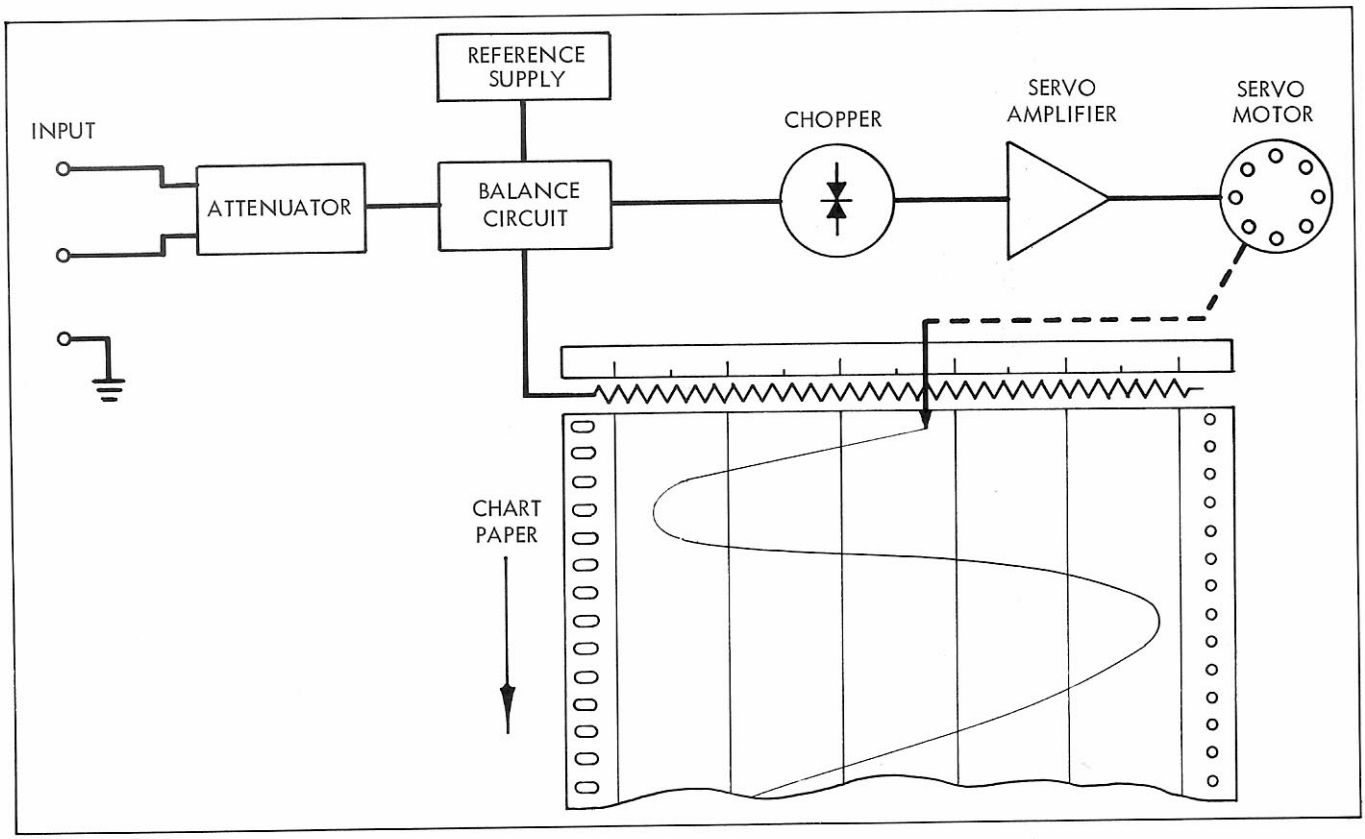


FIGURE 4-1. BLOCK DIAGRAM

minimum current drain from the signal source. Both models may be converted to this type of input. Full scale deflection is then obtained with 5 millivolts applied to the input. The range switch must be set at the 5 millivolt range. Five millivolts applied to the input will then drive the pen full scale. Source impedance must be no greater than 1500 ohms. Conversion to potentiometric operation is described in Section V, paragraph 5-22.

4-10. INPUT FILTER. The input signal is applied across a three section RC filter to minimize noise and ripple factors. The filter components are resistors R-110, R-122, R-123, and capacitors C-102, C-103, C-104. For component location see Section VII.

4-11. REFERENCE SUPPLY. The reference voltage is derived from a zener controlled DC power supply, nominally 6 volts, stable to 0.05% with line variation up to ±10%. The primary of the transformer T-300 is supplied with either 115 or 230 Volts AC. A third secondary winding supplies the reference supply. Diodes CR-307 and CR-308 provide full wave rectification. The output is then filtered by an RC filter composed of R-303 and C-303. Two stages of zener regulation is provided by R-305, CR-310 and R-306, CR-311. Diode CR-310 has high regulating ability and is used to reduce the line voltage variation appearing in the rectified output. Diode CR-311 is a highly stable zener diode which further regulates the output of the previous stage for greater stability. This diode is operated at current and voltage levels which provide temperature compensation for the reference supply.

4-12. BALANCE CIRCUIT. After passing through the input attenuator, the DC input signal is applied to the balance circuit where it is opposed by a DC cancellation voltage from the internal reference supply. The difference between these two voltages (error signal) is applied to the servo amplifier which drives the servo motor. The rebalance potentiometer R-129, being mechanically coupled to the servo, is driven in a direction to produce a voltage which cancels the error signal produced by the input voltage. The calibrate potentiometer R-128 adjusts the calibrate voltage appearing across the rebalance potentiometer so that the servo balances at full scale with 5 millivolts. Resistance in the balance circuit is sufficiently high for the balance potentiometer to impose little current drain on the reference supply, but low in value compared to R-125. This holds the loading and linearity of the balance potentiometer within the accuracy limits of the instrument. DC attenuation by R-124 reduces noise at R-129 by better than 200 to 1. This noise is predominantly the result of two effects, imperfect contact of the slider on the resistance element (in R-129) during travel resulting in a saw tooth component of noise voltage, and a triboelectric DC voltage generated by friction of dissimilar metals. R-121 provides ZERO control. This potentiometer introduces into the balance circuit a controlled error signal which is cancelled in the same manner as a regular input error signal. This control provides a means for placing zero anywhere within the graph limits.

4-13. CHOPPER AND INPUT TRANSFORMER. The DC difference between the input signal and the

rebalance voltage (error signal) is converted to 60 cps (or 50 cps, depending upon the power frequency) by the chopper C-200. A phase shift and voltage dropping network provides the proper voltage and phase relationship to drive the chopper 90 degrees out of phase with the power line. The AC error signal output from the transformer will either lead or lag the powerline by 90 degrees, depending on the polarity of the DC error signal. The direction of rotation of the servo motor is determined by the relative phase excitation of its two windings and this phase sensing causes the motor to drive the pen carriage and coupled potentiometer in a direction to seek balance. Total magnitude of the error signal varies with range setting from 5 mv to 100 mv. As the instrument must be sensitive to approximately 0.1% of this voltage, it is apparent that the error signals present are exceedingly small, actually in the microvolt region. With this in mind, all input circuitry is carefully engineered to minimize interference from stray hum pickup and thermal emfs.

4-14. DAMPING. Capacitor C-105 is connected to the wiper of the balance potentiometer R-129. It draws a charging current whenever a change in input occurs, thus increasing the rate of appearance of the balance voltage across resistor R-124. This phase advance in the slowly varying error signal causes an "anticipatory" approach to the balance point, producing damping.

4-15. FIVE STAGE VOLTAGE AMPLIFIER. Adequate voltage amplification of the error signal is provided by transistors Q-201, Q-202, Q-203, Q-204, and Q-205. The first four stages operate as class A voltage amplifiers and the fifth stage as class AB. All stages are connected in a conventional cascade circuit. The amplifier is separated into three sections by isolation filters composed of R-213, C-210 and R-214, C-213. Gain control is provided by potentiometer R-223 between the third and fourth stages of amplification. Feedback is incorporated in several places in the amplifier, the major feedback path being from the collector of Q-203 to the emitter of Q-202 through R-216.

4-16. DEMODULATOR. The motor control or demodulator section is shown in simplified form in figure 4-2. Power to drive the DC servo motor is taken from a separate winding on power transformer T-300. The direction of motor rotation is determined by the direction of current through the armature; control of motor current is provided by Q-206 which operates class B. The four modes of operation of the demodulator are determined by the relative phasing of the voltages at points A and B. Point A is excited by the line voltage appearing in the secondary of power transformer T-300. The polarity of point B is determined by the error voltage amplifier output and will be either in phase or 180° out of phase with the line as determined by the error voltage applied to chopper C-200.

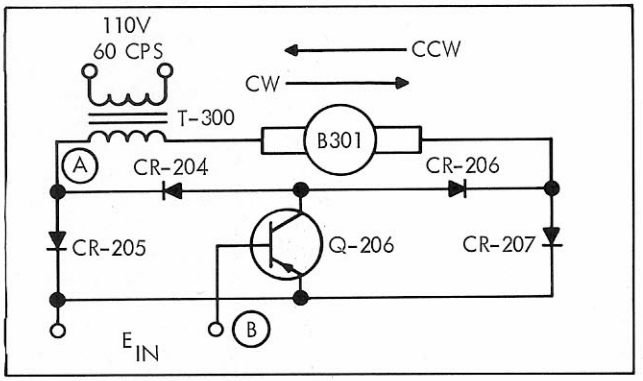


FIGURE 4-2. MOTOR CONTROL AND DEMODULATOR

Mode 1 Current flows from T-300,
A- passes thru B-301, then
B- thru CR-207, Q206, and thru C-204 back to T-300. The motor will rotate right.

Mode 2 Current flowing from T-300
A+ is blocked by Q-206. No
B+ current will flow and motor will not rotate.

Mode 3 Current flows from T-300
A+ thru CR-205, Q-206, and
B- CR-206, then thru B-301 back to T-300. The motor will rotate left.

Mode 4 Current flowing from T-300
A- is blocked by Q-206. No
B+ current will flow and motor will not rotate.

4-17. SERVO MOTOR. The servo motor is a DC type with permanent magnet field. Direction of motor rotation is determined by the direction of current flow through the motor armature. The motor shaft is geared to a Delrin gear which couples to the drive sheave through a friction clutch. The opposite end of the drive shaft may be coupled to a number of standard recorder accessories; e.g., output potentiometers, limit switches, and digital shaft encoders. The motor is part of the servo potentiometer and motor assembly.

4-18. POWER SUPPLIES. Power transformer T-300 provides operating power to the reference supply (paragraph 4-11), the motor control circuits of the demodulator (paragraph 3-16), and the servo amplifier (paragraph 3-15). These circuits are mounted on a plug-in assembly located in the top of the recorder. Operation from either 115 VAC or 230 VAC is permitted by proper positioning of switch S-303 located on top of the power transformer. The servo amplifier power supply employs silicon rectifiers CR-305 thru CR-307 in a full wave rectifying bridge circuit. The output is regulated by a conventional series regulator composed of C-302, Q-300, and zener diode CR-309. This power supply also furnishes excitation to the chopper through attenuator R-225, and to the electric pen control circuits. When inconcluded, the event marker circuits also receive power from this source.

4-19. CHART DRIVE SYSTEM. A sixteen RPM synchronous motor advances the chart paper through a gear assembly which provides chart speeds of 1, 2, 4, 8 inches per minute, and 1, 2, 4, 8 inches per hour on the Model 680; 2.5, 5, 10, 20 cm/min. 2.5, 5, 10, 20 cm/hr on the Model 680M. This assembly is illustrated in figure 4-3. The chart drive motor drives a cluster of reduction gears with a 2:1 reduction for each of four gears. The speed selector brings the 60:1 speed reducer into mesh with one of the four gears in the cluster. Selection of divisions per minute or hour and also neutral is determined by the gear train control. In the divisions/minute position an idler gear locks the input gear (A) and large spur gear (F) together. (Refer to figure 4-4.) Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ratio prevails. When the gear train control is moved to the divisions/hour setting the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating internally in the 60:1 speed charger thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear nor the lock key is engaged; therefore, the input gear rotates freely with no output. This position allows manual advance of the chart.

4-20. OPERATION OF 60 TO 1 SPEED CHANGER. The minutes to hours conversion mechanism consists of an epicyclic gear system illustrated in figure 4-4.

A spur gear (A) input to the speed changer serves as the carrier for the planet or idler gear (B). As the carrier gear rotates, the planet gear drives a sun gear (C) which has 60 teeth. The sun gear couples directly to the output spur gear (D) which advances the chart paper. Also in mesh with the orbiting planet gear (B) is a second sun gear (E) with 59 teeth. A modified tooth form permits the gears to mesh. The sun gear (E) is integral with a larger spur gear (F) which has a pitch diameter and number of teeth identical with the input carrier spur gear (A). The design arrangement permits the input carrier gear (A) to rotate free of the integral spur gear (F). When the spur gear (F) is locked in a fixed position by the spine on the control lever, the chart will advance in divisions per hour. When the input carrier (A) and spur gears (F) are locked together by the idler gear on the control lever, the resulting speed of the sun gear (E) will advance the chart in divisions per minute.

MODEL 681, 681M CIRCUIT DESCRIPTION

4-21. The circuit description of the Model 680, 680M also applies to the Model 681, 681M except for those circuits described below. The main circuit difference between the 680 and 681 is in the input circuit and chart drive system.

4-22. INPUT CIRCUIT. The input circuit is designed for single range input. This is selected by the customer from any of the ten standard ranges offered on the Model 680. This arrangement requires only two resistors R-109 and R-111. The values are determined by the selected range. R-100 prevents voltages greater than 5 millivolts from reaching the balance circuit.

4-23. POTENTIOMETRIC INPUT. This mode of operation is not available on the Model 681 due to the fact that the recorder is designed for a single input range.

4-24. BALANCE CIRCUIT. The description under Model 680 is applicable in every way.

4-25. DAMPING. The description under Model 680 is applicable in every way.

4-26. CHART DRIVE SYSTEM. A sixteen RPM synchronous motor advances the chart paper through a gear train designed to provide a customers selected speed. A second speed is produced by use of the 60:1 speed changer. The chart drive motor drives a gear train which meshes with the 60:1 speed reducer. Selection of divisions per minute or hour (thus two speeds) and also neutral, is determined by the gear train control.

In the divisions per minute position an idler gear is meshed with the speed changer locking the input gear (A) and large spur gear (F) together (refer to figure 4-4). Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ration prevails. When the gear train control is set at divisions/hour setting the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating in the speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear or the lock key is engaged; therefore, the input gear rotates freely with no output. This position allows manual advance of chart.

MODEL 682, 682M CIRCUIT DESCRIPTION

4-27. The Model 682 is a temperature recording device. Circuit description of the Model 680, 680M is also applicable to the Model 682, 682M except for those circuits described below. The main circuit difference between the 680 and 682 is in the input circuit and chart drive system.

4-28. INPUT CIRCUIT. The input circuit consists of a plug-in module incorporating a single cold junction compensated temperature range. A variety of plug-in modules are available for different temperature ranges and thermocouples. A listing of span limits for various thermocouple elements is contained in figure 4-5. The measuring thermocouple is connected to the instrument terminals with leads of the same thermoelectric characteristics as the thermocouple wires. The reference, or cold junction, is then at the recorder terminals where both terminals are at the same temperature. Compensation of the difference in temperature between the measuring junction and reference junction, or changes in temperature of the reference junction, is provided electronically. The positive resistance-temperature characteristic of a nickel wound resistor used in the circuit provides the necessary compensation. This resistor (R100) is mounted on a heat sink common with the reference junction so that it is affected by the same temperature as the reference junction. A change in temperature at the reference junction will

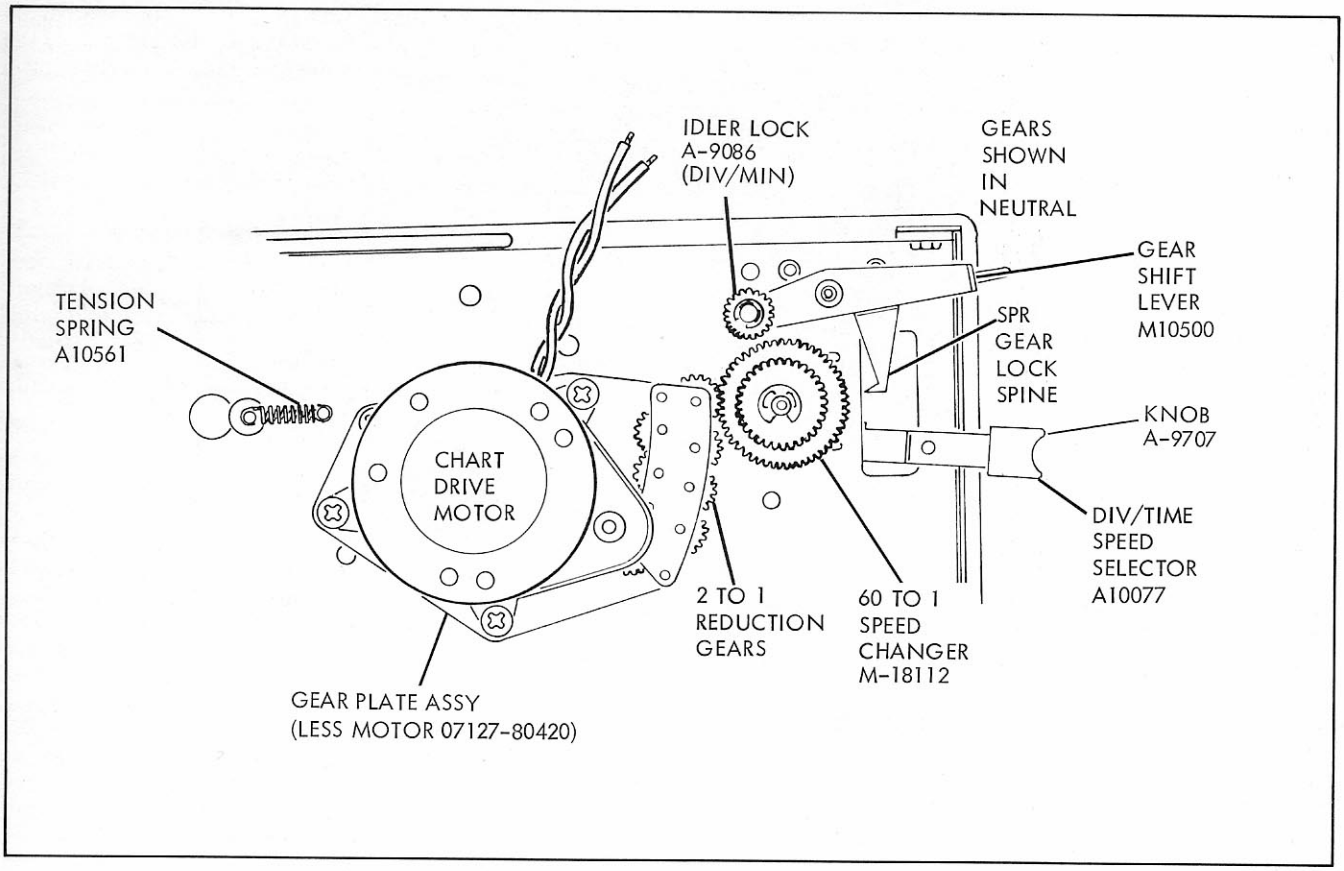


FIGURE 4-3. CHART DRIVE GEAR MECHANISM

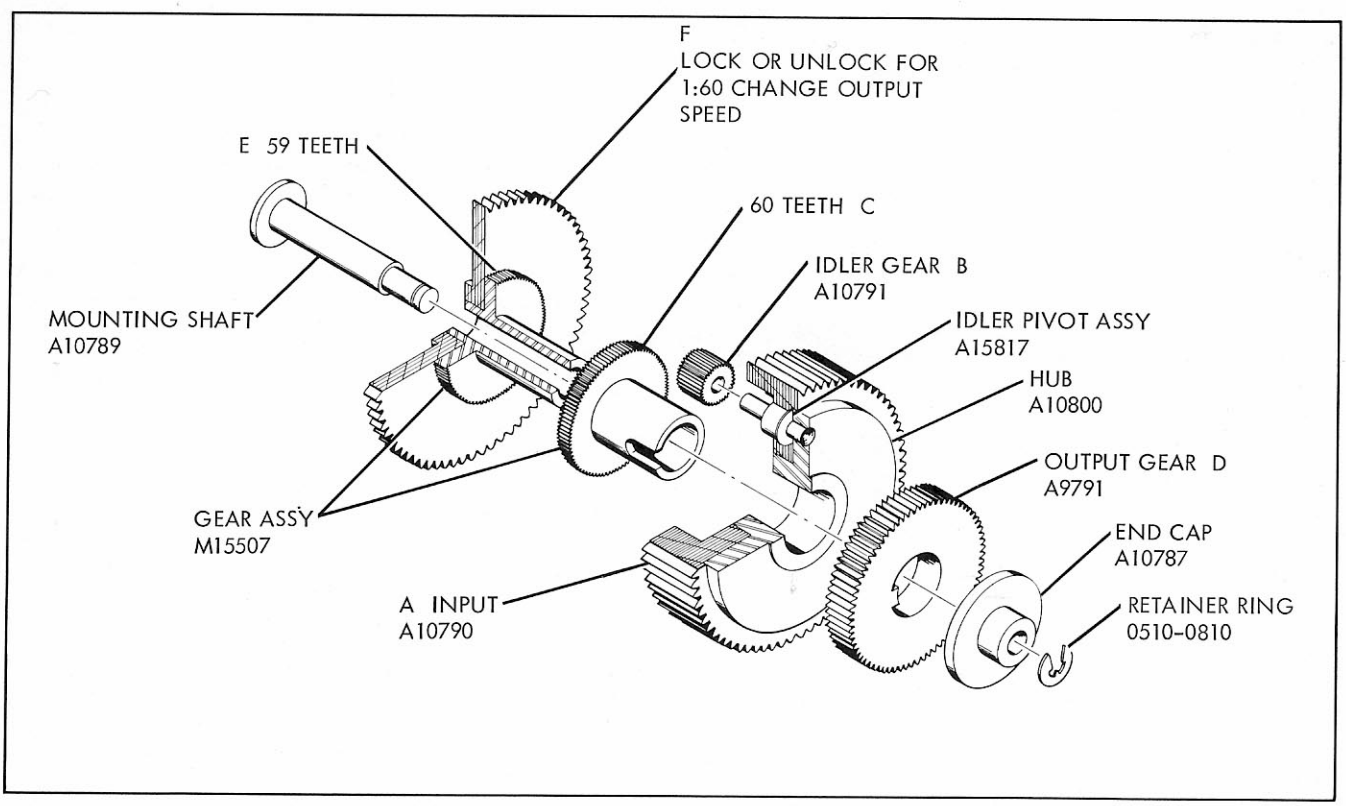
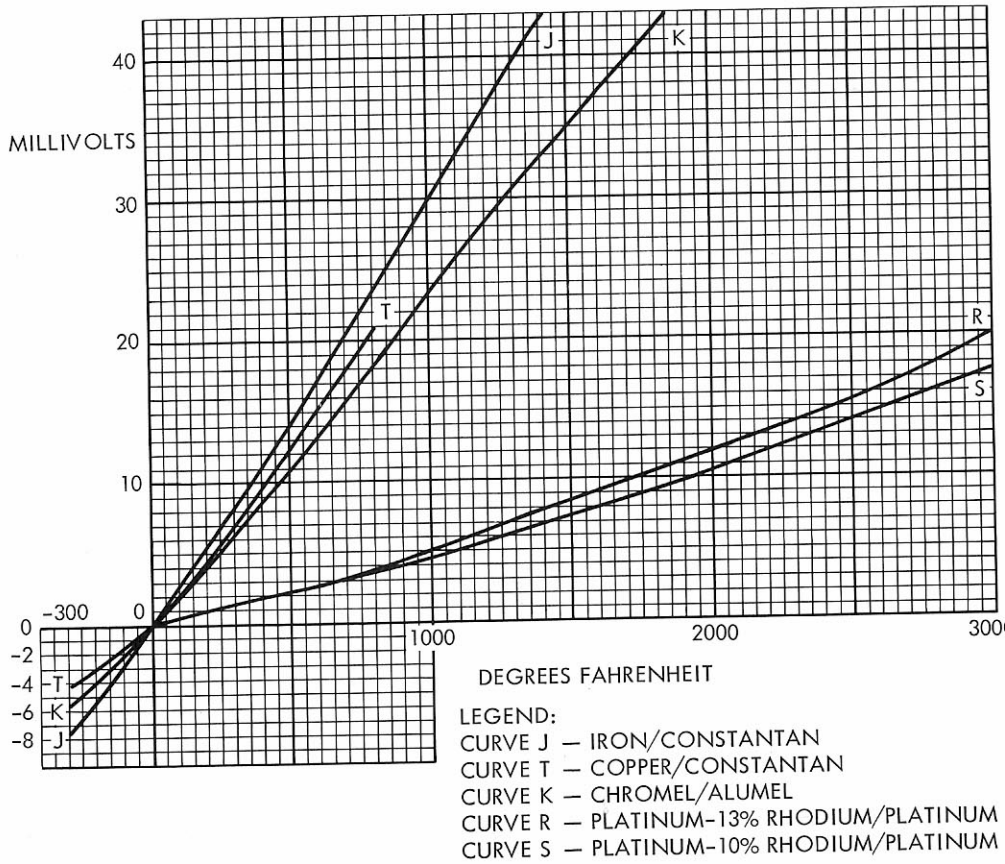


FIGURE 4-4. EPICYCLIC GEAR ASSEMBLY M-18112

SPAN LIMITS FOR COMMONLY USED COLD JUNCTIONS

TYPE	THERMOCOUPLE ELEMENT	TEMPERATURE RANGE CENTIGRADE Min.	Max.	TEMPERATURE RANGE FAHRENHEIT Min.	Max.	MINIMUM SPAN*	USE MODULE
J	IRON-CONSTANTAN	-200°	760°	-320°	1400°	100°C. 200°F.	TYPE R-2-J
T	COPPER-CONSTANTAN	-200°	400°	-310°	1800°	100°C. 200°F.	TYPE R-2-T
K	CHROMEL-ALUMEL	-200°	1370°	-310°	2500°	100°C. 200°F.	TYPE R-2-K
R	PLATINUM-PLATINUM (13% RHODIUM)	0°	1770°	32°	3100°	500°C. 1000°F.	TYPE R-2-R
S	PLATINUM-PLATINUM (10% RHODIUM)	0°	1770°	32°	3215°	500°C. 1000°F.	TYPE R-2-S

*Due to the non-linear response of thermocouples the minimum span may be smaller than the value shown. The limiting factor is not the temperature span but the difference between the thermocouple output voltages at each end of the selected span. This difference voltage must be approximately 5 millivolts, or more.



TEMPERATURE — MILLIVOLT RELATIONSHIPS FOR COMMONLY USED COLD JUNCTIONS
(32° Reference Junction; See Chart for Correct Input Module)

FIGURE 4-5. THERMOCOUPLE COLD JUNCTION COMPENSATION CHART

produce a change in emf. R100 is supplied with a constant voltage from the recorder reference supply and has a thermal/resistance characteristic which causes the voltage across R100 to change with temperature by just the voltage generated by the reference junction. This voltage opposes the voltage produced at the reference junction and is of equal amplitude, thus blocking both voltages from the amplifier.

4-29. POTENTIOMETRIC INPUT. This mode of operation is standard in the Model 682. Potentiometric input provides maximum sensitivity with minimum current drain from the measuring thermocouple. Both models employ this type of operation. Full scale deflection is obtained with the maximum voltage available from the measuring thermocouple. Source impedance must be no greater than 1500 ohms.

4-30. INPUT FILTER. Due to the pure DC input no input filter is required on the Models 682 or 682M.

4-31. BALANCE CIRCUIT. (Refer to schematic.) The DC input signal is applied to the balance circuit where it is opposed by a DC cancellation voltage from the internal reference supply. The difference between the internal reference voltage and the applied voltage (error signal) is applied to the servo amplifier which drives the servo motor. The rebalance potentiometer, being mechanically coupled to the servo, is driven in a direction to produce a voltage which cancels the error signal produced by the input voltage. The calibrate potentiometer adjusts the calibrate voltage appearing across the rebalance potentiometer so the servo balances at full scale with the maximum voltage received from the measuring thermocouple. Resistance in the balance circuit is sufficiently high for the rebalance potentiometer to impose little current drain on the reference supply, but low in value compared to R-125. This holds the loading and linearity of the balance potentiometer within the accuracy limits of the instrument. DC attenuation by R-119 reduces noise at the rebalance potentiometer R-129 by better than 200 to 1. This noise is predominantly the result of two effects, imperfect contact of the sliders on the resistance element in the rebalance potentiometer during travel resulting in a saw tooth component of noise voltage, and a triboelectric DC voltage generated by friction of dissimilar metals. The zero control introduces into the balance circuit a controlled error signal which is cancelled in the same manner as a regular input error signal. This control provides a means of absolute calibration against a standard signal.

4-32. CHOPPER AND INPUT TRANSFORMER. The description in the 680 section (paragraph 3-13) is applicable for the Model 682. However the magnitude of the error signal is not restricted to 5 millivolts.

4-33. DAMPING. Capacitor C-105 is in series with the wiper of the rebalance potentiometer R-129. This capacitor draws a charging current wherever a change in input occurs, thus increasing the rate of appearance of the balance voltage across resistor R-119. This phase advance in the slowly varying error signal causes an "anticipatory" approach to the balance point, producing damping.

4-34. CHART DRIVE SYSTEM. A sixteen RPM synchronous motor advances the chart paper through a gear train designed to provide a customer selected speed. A second speed is produced by use of the 60:1 speed changer. The chart drive motor drives a gear train which meshes with the 60:1 speed reducer. Selection of divisions per minute or hour (thus two speeds) and also neutral is determined by the gear train control. In the divisions/minute position an idler gear locks the input gear (A) and large spur gear (F) together (refer to figure 4-4). Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ration prevails. When the gear train control is set at divisions/hour setting the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating internally in the speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear or the lock key is engaged, therefore the input gear rotates freely with no output. This position allows manual advance of chart.

MODEL 683, 683M CIRCUIT DESCRIPTION

4-35. The Model 683 is a current recording device. Circuit description of the Model 680, 680M is also applicable to the Model 683, 683M except for those circuits described below. The main circuit difference between the 680 and 683 is in the input circuit and chart drive system.

4-36. INPUT CIRCUIT. The input circuit is designed for single range input. This is selected by the customer down to a minimum available range of 5 microamperes full scale. This circuit has only a single small value resistor R-111 in shunt with the input terminals.

4-37. BALANCE CIRCUIT. The description under Model 680 is applicable in every way.

4-38. DAMPING. The description under Model 680 is applicable in every way.

4-39. CHART DRIVE SYSTEM. A sixteen RPM synchronous motor advances the chart paper through a gear train designed to provide a customer selected speed. A second speed is produced by use of the 60:1 speed reducer. Selection of divisions per minute or hour (thus two speeds) and also neutral is determined by the gear train control. In the divisions/minute position an idler gear is meshed with the speed changer to lock the input gear (A) and large spur gear (F) together (refer to figure 4-4). Operation of the 60:1 speed changer is described in paragraph 4-20. In the position just described a 1:1 ratio prevails. When the gear train control is set at divisions/hour, the large spur gear (F) is locked in place. This results in the sun gear and planet gear rotating in the speed changer thus driving the output gear at a 60:1 reduction. In the neutral position neither the spur gear nor the lock key is engaged, therefore the input gear rotates freely with no output. This position allows manual advance of chart.

OPTIONS — CIRCUIT DESCRIPTION

4-40. OPTIONAL ELECTRIC WRITING. The power supply for the optional electric writing provides 28 VDC to the stylus. The 115 VAC power is applied to transformer T-400 which has a center tapped secondary connected to ground. The output voltage is rectified (full wave) by diodes CR-400 and CR-401, and filtered by capacitor C-400. The voltage is regulated by Q-400, R-400, and CR-402 with a constant voltage of 28.5 VDC. The 28.5 VDC is then current regulated by R-401 thru R-403, CR-403, and Q-401 for the servo stylus an independent current regulator R-404 thru R-406, CR-404, and Q-402 is provided for the event stylus.

SECTION V
MAINTENANCE

5-1. PREVENTIVE MAINTENANCE

5-2. GENERAL. The Model 680 Series Recorders must be maintained properly to obtain accurate, trouble-free operation. This requires periodic cleaning, performance checks, and visual and electrical checks. In accordance with good maintenance procedures for all precision electronic instruments. Recorders should be protected by covering when not in use.

5-3. ENVIRONMENTAL OPERATION. This instrument is designed to operate over an ambient temperature range of approximately 0°C to 55°C. Operation under other conditions will produce inaccurate results and may cause damage to the recorder. In areas with high humidity, graph paper may become distorted, affecting the accuracy of the grid lines. The area of operation should also be as free as possible of air contamination (soot, smoke, fumes, etc.). Excessive air contamination will require more frequent cleaning.

5-4. CLEANING. Thorough cleaning should be performed periodically. Intervals are determined by type of operation, local air contamination and climatic conditions. Generally, under normal use and conditions, cleaning intervals should be nine to twelve months. Cleaning routine should include the following:

a. Remove the chart magazine and top cover.

b. In inaccessible areas and where there is only dust accumulation, cleaning can be accomplished with an air gun. In more accessible areas and where the air gun will not remove the dirt, dust, or ink, accumulations should be removed with a sponge or cloth saturated in plain soap and warm water, then wiped dry.

c. SLIDER ROD. The slider rod (see figure 5-1) should be kept free of any oils or dust. Spray on Freon (supplied in Accessory Kit) and wipe off with a clean cloth. This should be done every 6 months.

NOTE: The slider rod should be kept clean and free of any lubricant. The "slidewire lubricant" in the Accessory Kit is used as corrosion and wear protection for the balance potentiometer, not for the slider rod.

d. BALANCE POTENTIOMETER. Cleaning and lubrication of the balance potentiometer depends on usage, local air contamination and how critical the user is. For best performance, balance potentiometer servicing should be performed every month. See Section 5-26 for cleaning and lubricating technique.

e. INK SYSTEM. Flush the ink system at least every 500 operating hours or every 90 days. See Section 5-13 for proper procedure.

5-5. LUBRICATION. Every 12th to 18th month, the servo motor pinion drive gear (see figure 7-4) should be greased sparingly with Enco G-350-GL (MIL-G-3278A). This is a high temperature grease designed to remain on the gears even if the motor(s) get hot. Be careful not to get the grease on the balance potentiometer. All other gears and bearings are prelubricated by the manufacturer and require no further lubrication.

5-6. VISUAL INSPECTION. During periodic cleaning and lubrication, a routine visual inspection should be performed. The following list is only general and inspection should not be restricted to these items.

1. Check the motor drive gears for proper adjustment (a slight amount of backlash) and for damaged teeth.

2. Inspect drive cable pulleys for binding.

3. Insure that the servo motor is mounted securely.

4. Check mounting screws on the amplifier and power supply to insure proper contact.

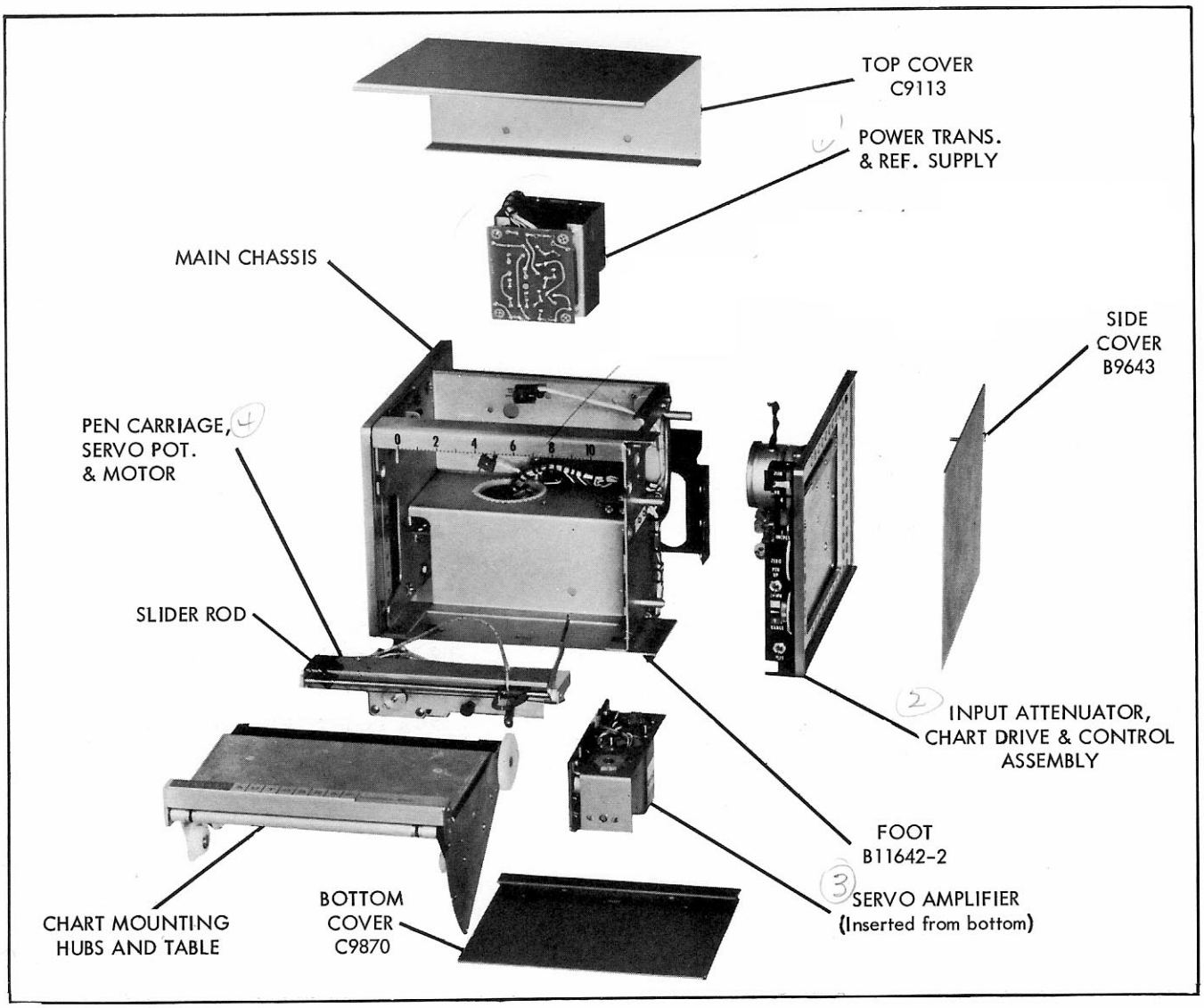


FIGURE 5-1. MAJOR ASSEMBLY DIVISIONS

5. Move pen carriage up and down listening for scrapes, grinding noises, etc., while feeling for any binding in the travel.

6. Check the drive cable for frayed or rubbing cables.

7. A check of components should include inspection for overheating, loose connections, cracked circuit boards, etc.

8. Check the drive chain for wear and damage.

5-7. PERFORMANCE CHECKS

5-8. The following performance checks will make the preventive maintenance procedure more effective in finding and eliminating potential problems:

a. DEADBAND CHECK.

1. Remove top cover of recorder.

2. Short recorder input.

3. Lower pen and start chart moving at about 2 in./min.

4. Use the zero control to set the pen on a division line on the graph paper.

5. Move the pen a little (less than 0.05") from null by pushing on the pen guard manually. Then slowly release the pen using your fingers as a drag, allowing the pen to return to null. Repeat in the opposite direction. The total deviation between these lines (see figure 5-3) is called deadband and should be no more than 0.1% of full scale (approximately half the width of the ink line). The most frequent reasons for excessive deadband are:

(a) Low gain of servo amplifier (see Section 5-22).

(b) Mechanical drag caused by a dirty slider rod (see Section 5-4, c) or excessive wiper tension.

b. DAMPING CHECK. (Note: Always check deadband first since this will affect damping.) Inspection of the recorder's response to a square wave will indicate recorder damping. The damping may also be checked by manually pushing the pen guard off null and then releasing it. Recorders are adjusted to overshoot between a maximum of 0.1 inch and a minimum of zero (critically damped). The two most frequent causes of poor damping are:

1. Low gain of servo amplifier (see Section 5-23).

2. Mechanical drag caused by a dirty slider rod (see Section 4-4c).

c. BALANCE POTENTIOMETER CHECK. A triangular wave drawn at moderate pen speed (1 in./sec) over the full recorder span will reveal a worn or dirty spot on the balance potentiometer. This condition is indicated by rough or jumpy spots which always reappear in the same relative position along the recorder span. See Section 5-26 for cleaning technique.

5-9. GENERAL MECHANICAL DISASSEMBLY

5-10. Access to the various components of the recorder is obtained as follows:

A. CHART MAGAZINE. Press the lever located below the power switch to the right and swing assembly up into a horizontal position. Now pull the magazine straight out of the recorder.

B. TOP PANEL: For servicing slidewire potentiometers, restringing, pen alignment, etc., remove two mounting screws, lift up the back of the panel and slide toward the rear of the instrument. When installing, insert lip of panel under aluminum strip and secure with the two screws.

C. SIDE PANEL: Although not usually required, the side panels may be removed as follows. Remove the four mounting screws. On earlier models no screws are visible on the outside and removal of two mounting screws on the inside require removal of the top and bottom cover.

D. REMOVAL OF PEN ASSEMBLY. For access to the pen, remove top panel (see paragraph B above) the chart magazine (paragraph A, above) and the trim strip. To remove pen, disconnect ink supply line and remove nut mounting pen to pen holder.

E. ATTENUATOR AND ZERO POTENTIOMETER REPLACEMENT. (Model 680 only.) Access to the zero potentiometer and attenuator requires the following:

1. Remove chart drive and recorder control assembly. This assembly mounts the gear train drive, chart drive motor, front panel and input terminals. To remove this assembly, proceed as follows:

a. Remove the right side panel (paragraph 5-10c).

b. From outside the recorder, remove three pan head screws which mount the entire assembly to the chassis.

c. Only limited movement is available due to existing wiring.

2. Use a flat 1/2" open end wrench to loosen locking nut on either the switch or potentiometer.

3. Unloop the drive chain and loosen the set screws holding the drive pulley to the component shaft.

4. Remove the drive pulley and separate the component from the recorder.

5. Unsolder wires and replace with new component.

F. CHART DRIVE MOTOR REPLACEMENT. If chart drive motor is to be replaced because of mechanical failure or to allow new chart speeds to be introduced, proceed as follows:

1. Separate the chart drive and recorder control assembly from the recorder chassis (see paragraph E).

2. Unsolder motor leads from terminal strip.

3. Remove the three machine screws holding the chart drive motor to the speed change turret assembly.

4. Remove and replace the motor.

G. TURRET GEAR SPEED CHANGE ASSEMBLY.

1. Remove the chart drive motor (see paragraph F).

2. Remove the two machine screws and one retaining ring holding the reduction gear and motor mounting bracket to the actuating lever.

3. Individual reduction gears may now be replaced by removing the gear shaft, inserting a new gear, and replacing shaft.

4. Reassemble.

CAUTION: After reassembling the turret gear speed changer assembly the hexagonal pivot slide eccentric on which the turret rotates must be adjusted so that the locating notches on the front radius of the turret plate engage the location pin when the gear shift lever is in the corresponding detent position.

H. 60:1 SPEED CHANGER AND LOCKING IDLER GEAR REPLACEMENT. These gear assemblies are held in place by retaining rings. Access to them requires removal of the chart drive and recorder control assembly.

5-11. DRIVE CHAIN LINKAGE REPLACEMENT. Replacement of a drive chain link may be accomplished as follows: (Refer to figure 5-7).

a. Remove the chart magazine.

b. Remove the graph paper.

c. Separate chain link with a small screwdriver.

d. A new drive chain link may be installed by snapping new links together.

e. It may be advantageous to loosen the 2 eccentrically mounted adjustment gears. Proper adjustment is explained in paragraph 5-12.

5-12. DRIVE CHAIN ADJUSTMENT. Proper adjustment is necessary for trouble-free operation. Incorrect adjustment can cause excessive wear, incorrect chart speeds, chain breakage, etc. Adjustments are provided in each of 2 eccentrically mounted gears. See figure 5-7.

a. Loosen the two mounting screws.

b. Rotate the eccentric mounting with a wrench, if necessary. Rotation should be just sufficient to remove any slack in the chain loop. Over-tightening may cause binding or excessive wear.

c. When the slack is removed, tighten the mounting screws.

5-13. PEN MAINTENANCE

5-14. PEN CLEANING. Pen writing failure may be caused by dried ink, sediment, air bubbles in feed line, long disuse, or oil on the pen tip or paper. Dried ink forms brittle crust particles which can build up in the supply line to stop ink flow. Pen assemblies should be cleaned thoroughly at regular intervals (90 days) or before extended storage. (Clean by flushing the system as shown in figure 5-2 with a mild detergent and water, then rinse thoroughly with water and dry with air. The syringe can be used for all these operations.)

5-15. STARTING THE PENS

1. Install new cartridge.

2. Start ink flow by placing a finger over the hole in the rubber bulb and then depress the bulb, as shown in figure 3-3. Keep the bulb depressed for several seconds, repeating as required until ink appears at the pen tip.

5-16. KEEPING THEM WRITING

1. The pen tip is durable, but extra care should still be used to prevent mechanical damage.

2. Oil or grease on the pen tip will degrade writing. Avoid touching the pen tip.

3. Flush the ink system, as indicated in 5-14 above, at least every 500 operating hours.

5-17. FIXING NON-OPERATIVE PEN

A. If the pen will not prime:

1. Check that the cartridge is tight.

2. Check the ink transfer tubing connections for air leaks and inspect the rubber primer bulb for cracks.

3. (a) Squeeze or push pen primer and hold.
(b) With the other hand, gently squeeze cartridge.
(c) Release bulb.
(d) Release cartridge.

Repeat sequence as necessary.

B. If the pen tip is clogged:

4. Connect the syringe to the pen tip with the plastic tube supplied. Withdraw ink from the cartridge. This should cure most stoppages.

5. If step A fails, run water and mild detergent through the pen system with the syringe. Flush system thoroughly with water followed by air. Use a new cartridge.

6. If all else fails, use the pen cleaning wire supplied. Great care should be used to prevent damage to the tip. The wire should be pushed straight in and out. Then flush the pen.

CAUTION: The pen tip should never be sanded or machined in any way.

5-18. PEN PERPENDICULARITY. One reason for poor or erratic writing (especially in one direction at high speed) is poor perpendicularity between the pen tip and the paper. The adjustment procedure is as follows:

a. Loosen the mounting screws at each end of the pen carriage bracket.

b. Loosen the adjusting screw on the left end of the assembly (as viewed from the front of the instrument).

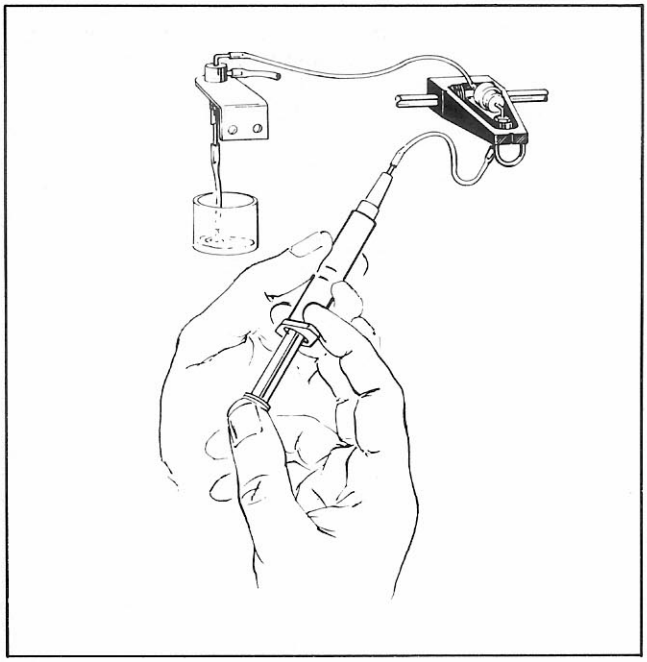


FIGURE 5-2. FLUSHING PEN SYSTEM

c. Push the entire assembly towards the rear of the instrument so the bracket fits firmly against the mounting screws.

d. Tighten the mounting screws.

e. With power applied, rotate the external zero control, if available, or apply a DC voltage to the input terminals to move the pen along one of the graph grid lines. Note any deviation.

f. Loosen the left hand mounting screw and turn the adjusting screw CW (as viewed from the rear of the instrument) while still driving the pen along the grid line, until the pen properly tracks the grid line.

5-19. PEN LIFT ADJUSTMENT. Travel adjustment of the pen carriage in either the raised or lowered position is provided by a set screw attaching the pen lift transfer arm to the solenoid plunger. Access to this bristol set screw is obtained by removing the top panel. Adjustment is made by loosening the set screw and sliding the arm forward on the shaft (towards the front of the recorder) to lower the pen, or backwards on the shaft to raise the pen. In the lowered position the pen should rest flat on the paper.

5-20. PEN TRAVEL ADJUSTMENT.

a. Remove the chart drive and chart magazines.

b. Loosen set screw holding the drive sheave to the motor drive unit.

c. Position the pen approximately 1/32 of an inch to the right of the full scale mark.

d. Manually rotate the drive sheave so the three-turn stop mechanism is at its maximum CCW position as viewed from the front of the instrument.

e. Tighten the set screw in the drive sheave.

f. Repeat to verify positioning as required.

5-21. ELECTRICAL MAINTENANCE

5-22. POTENTIOMETRIC OPERATION. This mode of operation provides essentially infinite input impedance at null. All troubleshooting done on the Model 680 Series Recorders should be performed with the input(s) connected to a voltage source with very low noise or else shorted. Failure to do this may give erratic operation, including excessive dead-band, slow response speed, and poor damping. To convert the Models 680 and 680M to potentiometric operation, a bus wire located on the input circuit board must be removed (refer to figure 7-9). Removal of this wire disconnects the shunt resistor across the input terminals. Both Models must be operated with the range selector in the 5 mv or 6 cm range. Source impedance should be no greater than 1500 ohms. This mode of operation may require an initial increase in gain setting to reduce servo dead zones. Full scale deflection is obtained with 5 mv on Model 680 and 6 mv on Model 680M.

NOTE: When operating in potentiometric mode the servos will not null without a load connected across the input terminals.

5-23. GAIN ADJUSTMENTS. The gain control potentiometers are located on the servo power amplifier. The gain control primarily affects Recorder's dead-band. Dead-band is the amount the measured quantity can be varied without initiating pen response. Because the gain control affects damping and recorder accuracy the gain control should be properly adjusted before damping is checked or calibration adjusted. The gain adjustment should be set (with a common tip screwdriver) no higher than necessary for firm servo control.

a. Extend the chart magazine to its last position (30°) to obtain access to the gain potentiometer.

b. Set the chart speed at lowest speed available.

c. Connect an accurate voltage source to the input terminals and regulate the voltage until the pen is in exact agreement with midscale.

d. Manually move the pen off null approximately 1/10" (2.5mm). Allow pen to return to null slowly. Do not simply release it. Repeat this operation in the opposite direction. The trace should appear similar to (c) in figure 5-4. If the pen does not return to the original setting as shown in (a) of figure 5-4, the gain is too low. Oscillation of the pen and excessive over shoot as illustrated in (b) of figure 5-4 indicates excessive gain.

e. Rotate gain adjustment screws CCW to decrease the gain and CW to increase it (as viewed from the front of the recorder). A long common tip screwdriver is required to make the adjustment from the front. Repeat step "d".

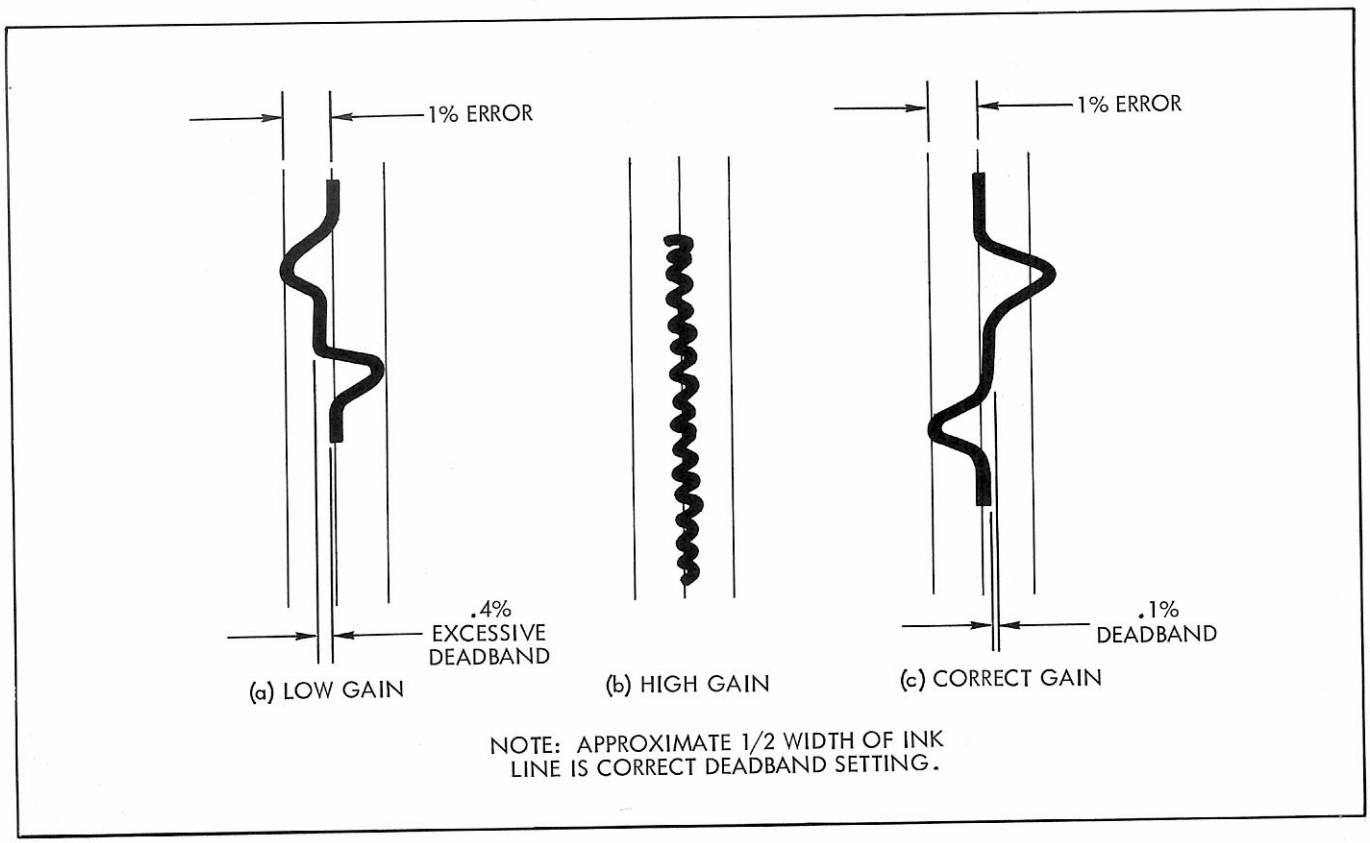


FIGURE 5-3. GAIN ADJUSTMENT CHART

f. Repeat above procedure until trace similar to (c) of figure 5-4 is obtained.

CAUTION: Setting the gain control too high will overheat the recorder. This may degrade the writing of the recorder (by changing the ink viscosity) and shorten the life of various components.

5-24. CALIBRATION. Reference voltage is Zener controlled, regulated, and temperature compensated. Drift or variation should be negligible. In the event calibration inaccuracies do appear, first check servo amplifier gain, Section 5-23. Recalibration may be accomplished as follows:

A. MODELS 680 AND 680M.

1. Remove the bottom cover to gain access to the calibrate control R-128.

2. Set the range switch to 1 volt full scale.

3. Adjust the zero control to bring pen to exactly "0" (left edge of graph).

4. Connect an accurately established one volt DC (as obtained, for example, from an H-P Model 740 DC Standard), to the input terminals. This signal will drive the pen to the right edge of the graph.

5. Adjust the calibration controls to bring pen into exact agreement with the full scale marking on the scale. Removal of the input signal should cause the pen to return to its original "0" position. Repeat calibration procedures until accurate repositioning is achieved.

6. In the event full scale cannot be reached by use of the calibration controls, the electronic reference supply should be checked for an output of approximately 6.25 volts (±5%).

B. MODELS 681 AND 681M.

1. Remove the bottom cover to gain access to the calibrate control R-128.

2. Adjust the zero control (internal adjustment) to bring pen to exactly "0" (left edge of graph).

3. Connect to the input terminals an accurately established DC voltage equivalent to the customer selected value required for full scale deflection. An L & N precision potentiometer and Weston Standard Cell is an accurate source for this voltage. This signal will drive the pen to the right edge of the graph.

4. Adjust the calibration control to bring pen into exact agreement with the full scale marking on the scale. Removal of the input signals should cause the pen to return to its original position. Repeat calibrated procedures until accurate repositioning is achieved.

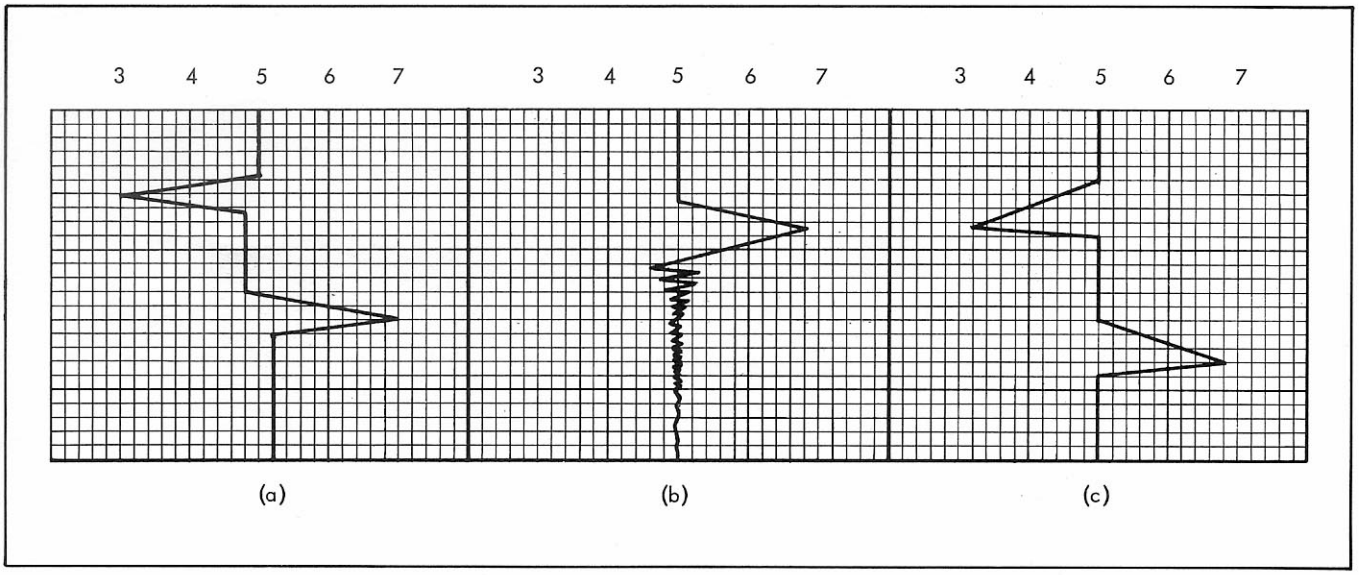


FIGURE 5-4. GAIN ADJUSTMENT CHART

5. In the event full scale cannot be reached by use of the calibration controls, the electronic reference supply should be checked for an output of approximately 6.25 volts (±5%).

C. MODEL 682 AND 682M (SPAN CALIBRATION).

1. Determine the millivolt equivalents for maximum and minimum temperatures for the thermocouple type employed. A reference table is available in the National Bureau of Standards, Standard Reference Tables for Thermocouples (Circular 561, dated 1955). Determine the full scale voltage span required by the recorder.

2. Remove the top, bottom and side panels.

3. Disconnect the measuring thermocouple from the input terminals. Energize the recorder.

4. Connect to the input terminals an accurate variable millivolt supply. Adjust this signal to place the pen in exact agreement with the left hand edge of the graph. Note the voltage required.

5. Designating the voltage determined in step 4 as "OFFSET", algebraically add it to the full scale span voltage determined in step 1. The algebraic sum of these voltages should drive the pen to exactly full scale at the right edge of the graph.

6. Using the calibration potentiometer, adjust the pen position until exact agreement with the full scale mark is achieved.

7. Recheck the low end of the scale (left edge) by reapplying the voltage determined in step 4. If a shift is noted, repeat calibration procedures from step 4 through step 7 until accurate repositioning is achieved.

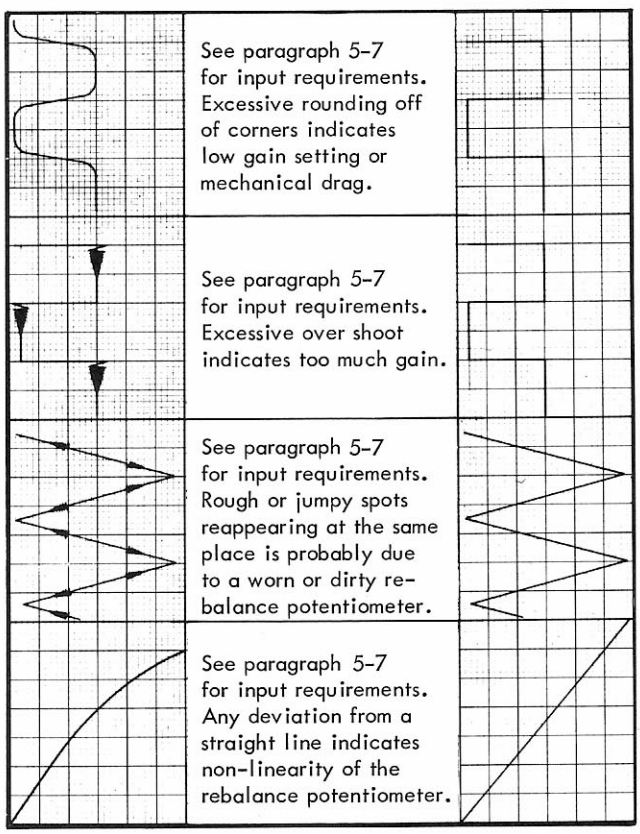


FIGURE 5-5. PERFORMANCE CHART

D. MODEL 682 AND 682M (ZERO CALIBRATION).

1. Instruments with spans including 0°C. This adjustment runs concurrent with the span calibration.

(a) Disconnect the millivolt supply used in the span calibration and reconnect the thermocouple to the input terminals.

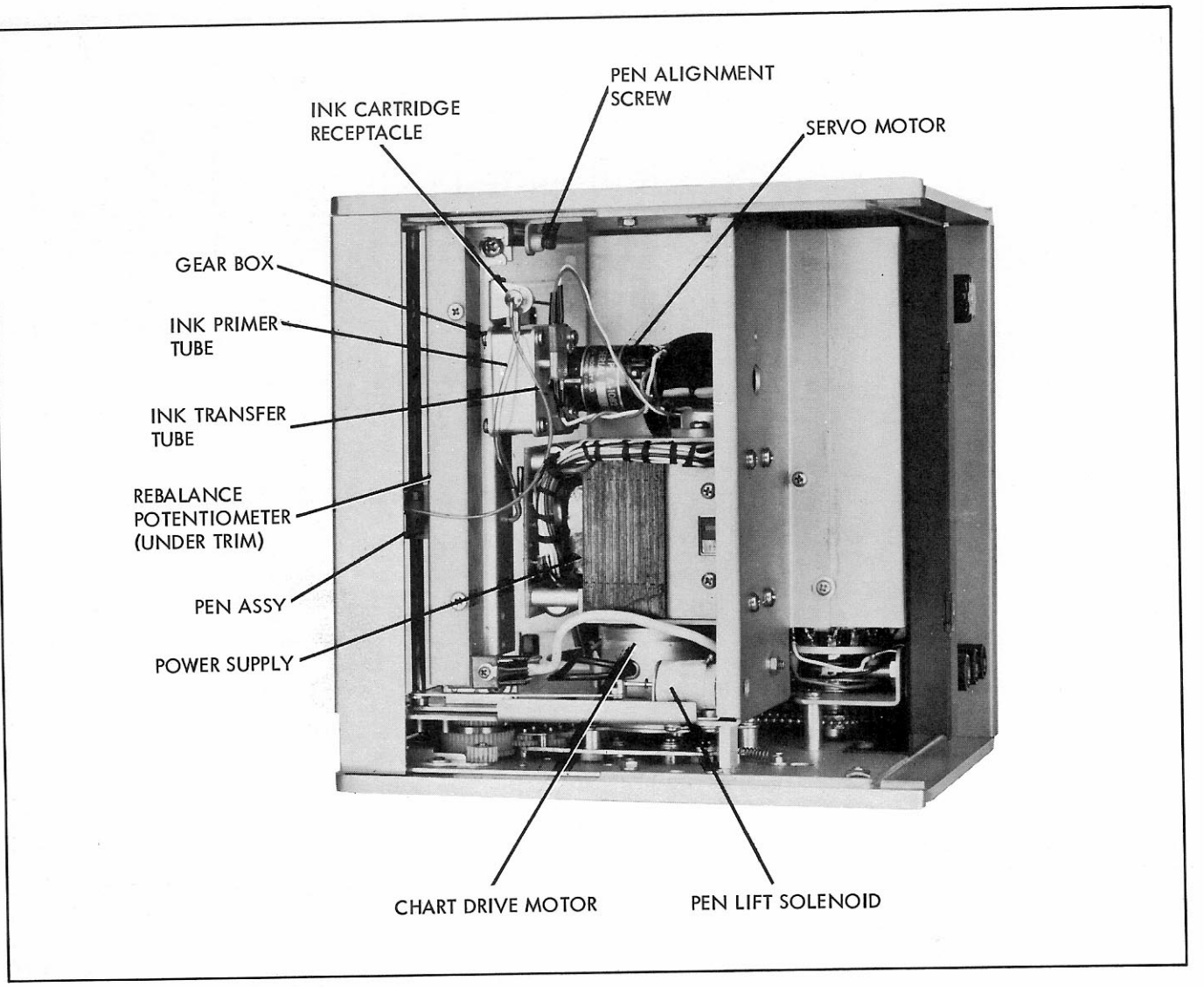


FIGURE 5-6. TOP VIEW OF MODEL 680

NOTE: Observe thermocouple polarity. Polarity is correct when an increase in temperature of the thermocouple causes up-scale movement of the recorder pen.

(b) Using the internal zero potentiometer, adjust the pen position to read the known temperature of the measuring thermocouple. This is conveniently done by immersing the measuring thermocouple in a mixture of ice and water and setting the pen at 0°C (32°F).

(c) This completes the calibration of the 682 or 682M with 0°C within the span.

.2. Instruments with spans not including 0°C. This adjustment runs concurrent with the span calibration.

(a) Accurately determine local room temperature. Determine the millivolt equivalent for this temperature from the NBS reference tables for the thermocouple type being used. Subtract this value from the millivolt value of the low end of the scale as determined in step "C4" of the span calibration procedure.

(b) From an accurate millivolt supply, apply the voltage determined in step (a) to the recorder input terminals.

(c) Using the internal zero potentiometer, adjust the pen position to exact agreement with the left hand edge of the graph (low end of scale).

(d) Disconnect the millivolt supply and reconnect the thermocouple to the input terminals.

CAUTION: Observe thermocouple polarity. Polarity is correct when an increase in temperature causes up-scale movement of the recorder pen.

(e) This completes the calibration of the 682 or 682M with 0°C out of the recorder span.

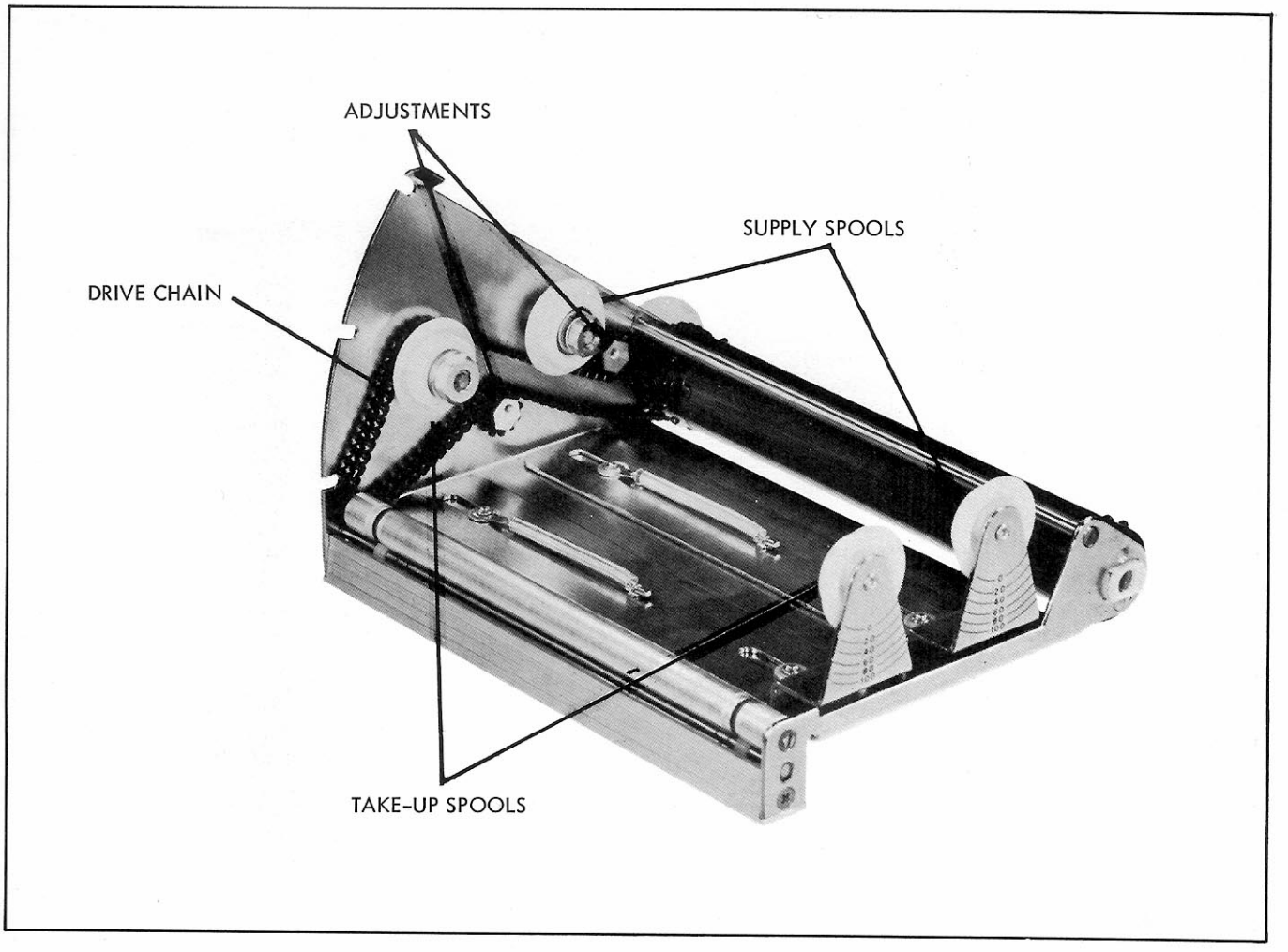


FIGURE 5-7. CHART MAGAZINE

E. MODELS 683 AND 683M.

1. Remove the bottom cover to gain access to the calibrate control R-128..

2. Connect a precision 1000 ohm resistor in series between the positive input terminal of the 683 or 683M and an accurate DC voltage source. Ground the negative terminals.

3. Connect a precision differential voltmeter, such as the Hewlett-Packard Model 741A, across the 1000 ohm resistor.

4. Adjust the internal zero control to bring the pen to exactly "0" (left edge of graph).

5. Calculate by ohms law the voltage drop which will develop across the precision resistor at full scale by multiplying the current value of the full scale span by the value of the precision resistor (1000 ohms).

6. Adjust the DC voltage source until a differential voltmeter reads the voltage calculated in step #5. This voltage should drive the pen to full scale.

7. Adjust the calibrate control to bring the pen into exact agreement with the full scale marking. Removal of the input signal should cause the pen to return to its original "0" position. Repeat calibration procedures until accurate repositioning is achieved.

8. In the event full scale cannot be reached by use of the calibration control, the electronic reference supply should be checked for an output of approximately 6.25 volts (±5%).

5-25. DAMPING CHARACTERISTICS. No damping adjustments are provided. A fixed damping circuit designed to provide slightly underdampened operation is described in Section IV, paragraph 4-14. Proper gain settings are necessary to produce optimum performance.

5-26. BALANCE POTENTIOMETER MAINTENANCE

5-27. BALANCE POTENTIOMETER CLEANING. Fundamental to the high accuracy of self-balancing servo recorders is the balance potentiometer. Contamination of the balance potentiometer by wear products, or frictional polymers, results in irregular or "jumpy" plots as the pen passes the particular position(s) contaminated. When this occurs, perform the following check:

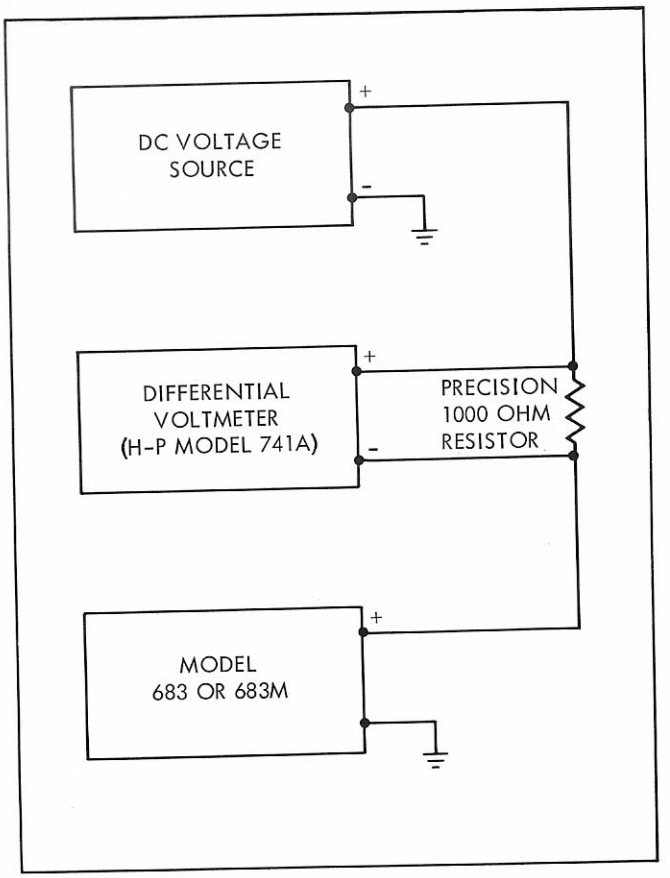


FIGURE 5-8. CALIBRATION HOOKUP DIAGRAM OF MODEL 683

a. Short the rear input terminals of the Recorder.

b. Move the pen through a full excursion using the zero control. If the pen appears "jumpy" at one or several precise positions, then the balance potentiometer must be cleaned. (Note: It is possible for the zero potentiometer itself to be noisy rather than the balance potentiometer.)

c. Remove the chart magazine to gain access to the pen balance potentiometer (see figure 5-1). To clean, spray on cleaner (from Recorder accessory kit) and wipe the resistance element at right angles to the length of the potentiometer and lengthwise on the return buss. Kimwipes, or lint-free tissue works well. Immediately apply the balance potentiometer lubricant from the accessory kit to both the slidewire and return buss to protect the potentiometer from wear.

d. If noise is not apparent with shorted input check incoming signal for excessive noise.

5-28. WIPER INSPECTION, ADJUSTMENT, AND REPLACEMENT. Ordinarily, the balance potentiometer wiper does not require adjustment, but a quick check for adjustment and wear should be made when a good compromise between dead-band and smoothness of writing (too much noise) cannot be found, or when the balance potentiometer requires more frequent cleaning than when new.

a. Remove the rebalance potentiometer (see paragraph 5-29). This allows access to the wiper mounting screw on the pen carriage.

b. After step a, the wipers will be in clear view. Check for dirt or contamination build up on contact surfaces. Compare the wiper with that of figure 5-9, which has excess wear. Normally only the wiper must be replaced. The wipers can then be removed with a small screwdriver.

c. To check wiper adjustment, move the pen block until its lip just touches the edge of the scale mount extrusion. In this position, both wiper fingers should have just made contact with the return buss and the resistance element. If the wiper does this correctly, then when the wiper block is returned to the slot in the back of the scale, the wipers will have the correct contact pressure against the balance potentiometer. The wipers can be adjusted by carefully lifting or pushing them.

5-29. BALANCE POTENTIOMETER REPLACEMENT. Replacement of the balance potentiometer (mandrel) is generally due to physical damage rather than wear.

1. Remove the top cover and chart magazine as described in paragraph 5-10 A and B.

2. Remove the potentiometer cover mounted by two screws.

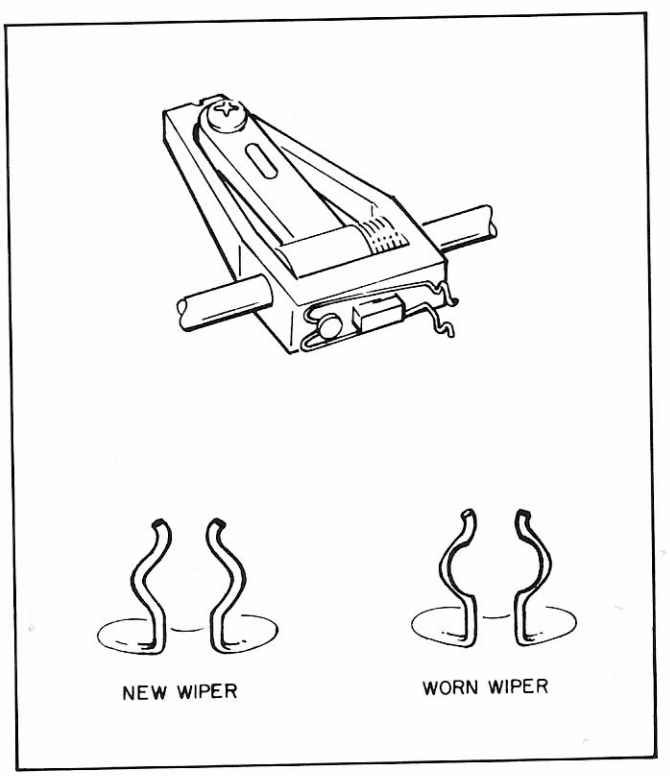


FIGURE 5-9. WIPER INSPECTION

3. Unplug the electrical connection from the servo system.

4. Remove the three screws mounting the potentiometer to the bracket and remove the potentiometers.

CAUTION: Care should be exercised in removal of the potentiometer to prevent damage to the slidewire or wiper. When reinstalling, both wiper contacts should be carefully placed on the appropriate mandrel or solid wire.

5-30. SERVO MOTOR MAINTENANCE

5-31. After several days of storage, a slight improvement in retrace characteristics may be produced by several high speed full scale excursions.

5-32. SERVO MOTOR BRUSH REPLACEMENT. It is not recommended that worn out motor brushes be replaced. By the time the motor brushes need replacement, other motor components will probably also need replacement. It is therefore recommended that the entire motor be replaced with new units. However, if it seems advisable to replace the brushes, follow the steps listed below. It is possible to install new brushes without removing the motor from the recorder, depending upon the angular position of the motor. If the motors are to be removed, refer to Paragraph 5-35, then proceed as follows:

a. Remove the two solder lug mounting screws. (Note the polarity of the lugs and mark to avoid a phase reversal when reassembling.

b. Pivot the brush springs outward and pull the brushes out of their holes.

c. Clean the brush holes and install new brush assemblies, H-P No. A-18671. Note: Position new brushes so the arc on the bottom of the brush matches the curvature of the commutator.

d. Swing the springs back to their original position and hook under the flange on the solder lug.

e. Make sure the brush can move down without its lead interfering. Reinstall the motor as described in Paragraph 5-35.

5-33. CORRECTION OF STICKING MOTOR BRUSHES. The most common cause of a sticking motor brush is an interference between the motor body and the brush lead wire, preventing the brush from moving downward. By carefully repositioning the lead, the brush can be freed. Other possible causes of a sticking brush are burrs in its hole or an accumulation of foreign matter. If either of these are the cause, the motor will have to be removed and cleaned or replaced.

5-34. SERVO MOTOR GEAR MESH ADJUSTMENT. Excessive backlash of the servo gear drive system may be corrected as follows:

a. Loosen the three mounting screws on the motor mounting bracket.

b. Rotate the eccentrically mounted motor until the drive gear meshes properly with the motor spline without binding. A small amount of backlash is necessary.

c. Retighten the mounting screws.

5-35. SERVO MOTOR REPLACEMENT. Should replacement of the DC servo motor be indicated, proceed as follows:

a. Remove the servo potentiometer and motor assembly. Located in the upper front portion of the recorder, this assembly includes the rebalance

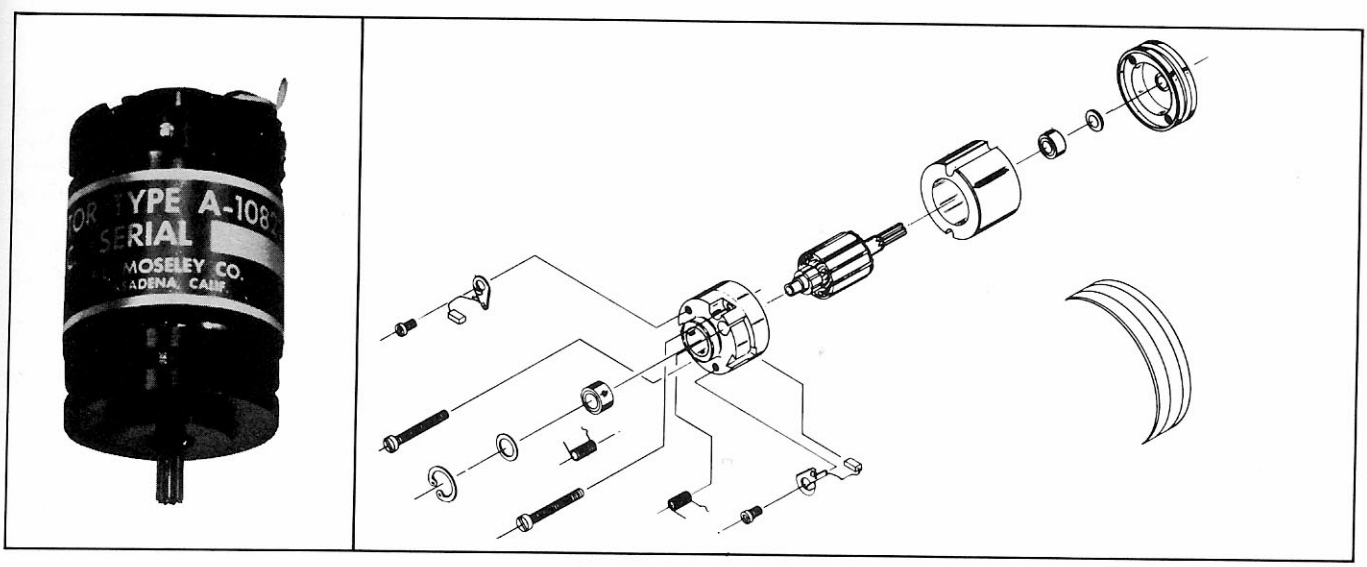


FIGURE 5-10. SERVO MOTOR

potentiometer, servo motor, recording pen and ink cartridge.

1. Remove the top cover and chart magazine.

2. Separate the two connectors, one attached to the potentiometer, the other to the servo motor.

3. Loosen the screws holding each end of the entire assembly to the recorder chassis.

4. Release the mechanical connection to the pen solenoid.

5. Slide the assembly forward, down, and out through the front of the recorder.

CAUTION: After servicing this assembly, the pen should be aligned to move perpendicular with the chart advance. Refer to paragraph 5-18.

b. Unsolder motor leads from terminals.

c. Loosen the three screws mounting the servo motor to the motor drive unit and turn the mounting clips out of the way.

d. Pull the servo motor to the rear of the assembly separating the splined motor shaft from the motor drive unit gear and clutch assembly.

e. Install new servo motor and adjust backlash (see paragraph 5-35).

5-36. RESTRINGING INSTRUCTIONS

5-37. DISASSEMBLY. To restring any of the 680, 681, 682 or 683 series, the top cover and chart magazine must be removed.

5-38. MATERIALS REQUIRED. Before attempting to restring to recorder, the following materials should be available:

a. Nylon cable assembly, H-P Part No. 8160-0050 20"long.

b. Washer, H-P Part No. A-10677.

c. Spring, H-P Part No. A-10678.

5-39. RESTRINGING PROCEDURE.

a. Remove the servo potentiometer and motor assembly (see paragraphs 5-29 and 5-35).

b. Place the assembly in an inverted position with the motor away from the operator, as illustrated in figure 5-11.

c. Move the pen to the right end of the drive movement.

d. Insert one end of a piece of nylon drive cable at least 20 inches long through the pen block stud (E), tension spring (F), and washer (G).

e. Proceed from this assembly point (A) around the pulley (B) to drive sheave (C). The drive sheave should be positioned against its stops in the CW direction. The small hole in the drive sheave should be approximately horizontal.

f. Proceed CCW approximately 1/4 turn around the drive sheave and insert the cord through the hole in the drive sheave from the right side.

g. Pull through all slack and wind 3-1/4 turns around the drive sheave in a CCW direction.

h. Continue around pulley (D) and back to assembly point (A).

i. Insert this end of the cord through the stud assembly, spring and washer.

j. Loosen the starting end of the cord from the washer (G) and take up slack by drawing on both ends at once.

k. With the tension spring in compression and the washer flush with stud (E), tie the ends of the cord together in a knot large enough to prevent slipping through the retaining washer (G).

l. Manually move the pen across the recorder carriage. Make sure that the stop assembly in the motor drive unit does not terminate the pen movement before full scale travel has been permitted.

5-40. TROUBLESHOOTING

5-41. GENERAL. Troubleshooting of the 680 series should be performed in a logical manner. The concept of bracketing should be employed, i.e., establishing circuits or sections which are not operating or are operating abnormally. This is generally the fastest way to locate trouble in a closed loop circuit. The block diagram in Section IV should be utilized for localizing trouble.

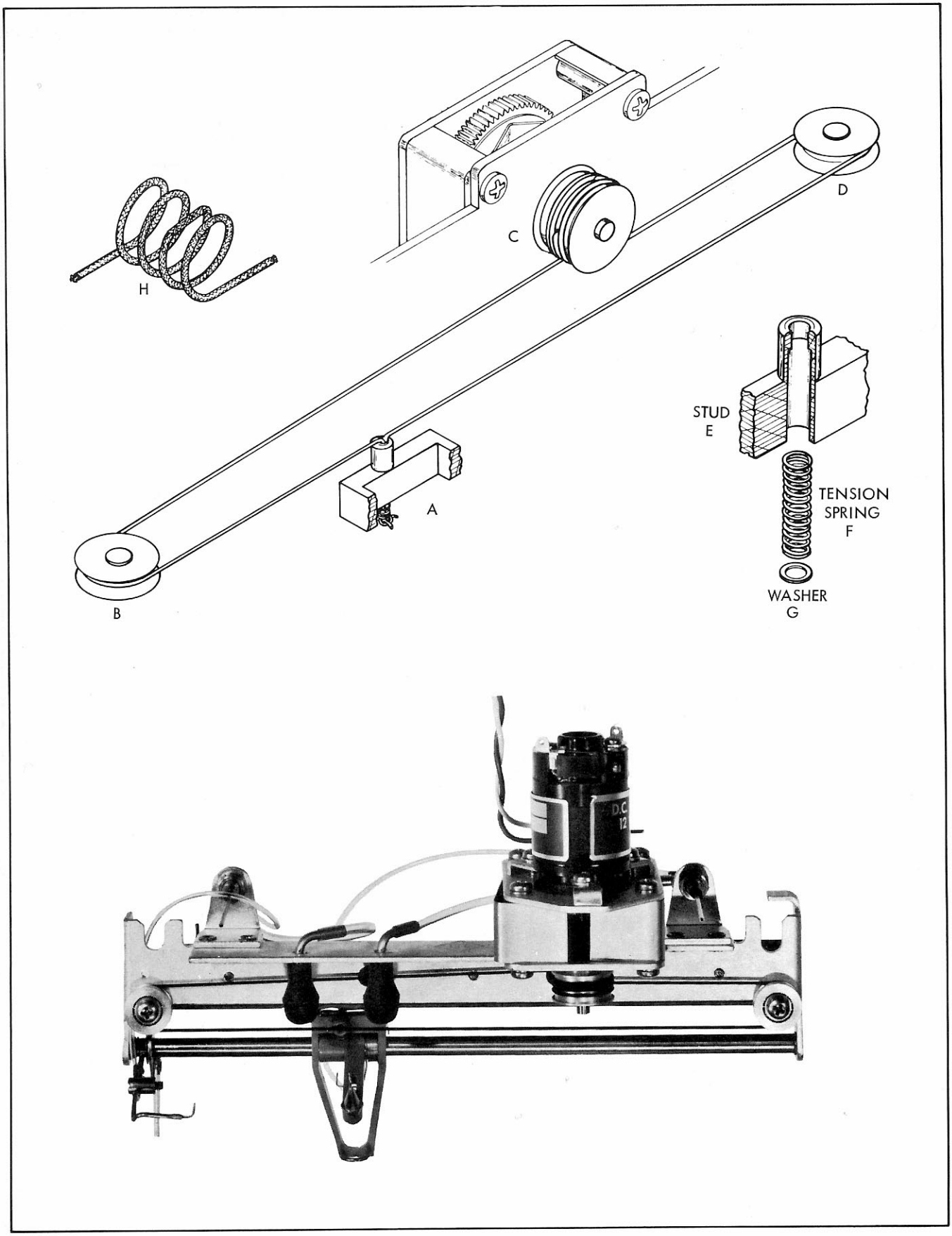


FIGURE 5-11. RESTRINGING DIAGRAM

PROBLEM	POSSIBLE CAUSE	CURE
1. Noisy or rough trace.	1. Instrument not grounded.	1. 115/230 VAC power GND required.
	2. Worn or dirty potentiometer.	2. See paragraphs 5-26 and 5-27 for tests and corrective procedures.
	3. Insufficient contact pressure or improper positioning of wiper on slidewire balance potentiometers.	3. Contact at 45° angle before installation with contact pressure of 15 grams (approximate values).
	4. Noisy transistors in amplifier.	4. Check TP-2; if noise is present, check TP-1. This will localize the trouble to a few components.
	5. Defective zener diode.	5. Replace diode CR-311.
2. One position of the pen produces excessive jitter that repeats each time the pen reaches this position.	Dirty balance potentiometer	Clean per Section 5-26.
3. Excessive pen jitter (small amplitude). NOTE: If 1 or 2 occurs very frequently, the balance potentiometer wiper may need adjustment or be badly worn. See Section 5-28.	a. Excessive input signal noise	a. Short recorder input to see if jitter stops.
	b. Dirty balance potentiometer.	b. Clean per Section 5-26
	c. Servo amplifier gain set too high.	c. Decrease gain per Section 5-23.
4. Pen skips when writing at high speed.	a. Poor perpendicularity between pen tip and chart paper.	a. Adjust per Section 5-18. b. Replace.
5. Pen won't prime.	a. Cracked rubber primer bulb.	a. Replace.
	b. Cartridge not secure.	b. Replace cartridge if loose (see 3-21).
	c. Ink supply tubing not connected tightly.	c. Push tubing further on fittings with fingers.
6. Pen stops writing.	a. Clogged with sediment or paper fiber in pen tip.	a. Using syringe and tubing in accessory kit. Withdraw ink from pen tip. (See figure 5-2.)
	b. Oil or grease on pen tip (from touching with fingers).	b. Clean (Section 5-14).
	c. Clogged primer air line.	

FIGURE 5-12. TROUBLESHOOTING CHART (SHEET 1 OF 2)

PROBLEM	POSSIBLE CAUSE	CURE
7. Bubbles in ink supply line.	a. Recorder overheated due to excessive noise on input signal or servo amplifier gain set too high.	a. Check servo gain per paragraph 5-23.
8. Excessive deadband (poor notch, poor resettability).	a. High noise content on input signal (60 Hz). b. Excessive drag because of dirty slider rod. c. Low servo amplifier gain.	a. Short input to check. b. Clean with Freon supplied in accessory kit. c. Adjust per Section 5-23.
9. Recorder response slow.	a. High noise on input signal. b. Servo gain control set very low. c. Drag due to dirty slider rod. d. Excessive wiper pressure.	a. Short input to check. b. Adjust (Section 5-23). c. Clean with Freon supplied in accessory kit. d. See paragraph 5-28.
10. Damping poor. More than 0.1 inch overshoot.	a. Servo amplifier gain set too low. b. Damping capacitor C-105 open circuited.	a. Adjust per Section 5-23. c. Remove and check.
11. Chart speeds slower than settings.	a. Chain too tight.	a. See chain drive adjustment, paragraph 5-12.

FIGURE 5-12. TROUBLESHOOTING CHART (SHEET 2 of 2)

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains parts list, one year isolated spare parts list, mechanical parts identification, and ordering information.

6-3. PARTS LIST

6-4. Figure 6-1 lists parts in alphanumerical order by schematic circuit symbols. Parts not designated on the schematics are listed at the end of figure 6-1 under a separate sub-heading. There is only one parts list for the entire 680 series. Model numbers with applicable part numbers and description are provided for each symbol. Model numbers include metric units and options unless otherwise specified.

6-5. RECOMMENDED SPARES

6-6. Figure 6-2 lists all components with mortality experience. Recommended quantities to stock for maintaining the instrument for a one year period are designated in the RS column.

6-7. MECHANICAL PARTS IDENTIFICATION

6-8. A thorough breakdown of mechanical and electromechanical components is provided in Section VII. These illustrations are useful for parts identification and assembly/disassembly information.

6-9. ORDERING INFORMATION

6-10. Order all replacement parts from your local Hewlett-Packard Sales/Service Office (see addresses in back of this manual). The order should include part number and description from this section. If the required part is not listed in this section provide model and serial numbers of the instrument. Describe the part including function and location.

MODEL 680 GENERAL WIRING (Refer to Schematic C-15457)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
B300	All except 681, 682, 683	M18424	Chart Motor, 60 Hz	Hewlett-Packard	M18424
	681, 682, 683	(see figure 6-4)	Chart Motor, 50 and 60 Hz	Hewlett-Packard	See figure 6-4
	Option 10	17999-19649	Chart Motor, 50 Hz	Hewlett-Packard	17999-19649
B301	All	A10822	Motor-servo	Hewlett-Packard	A10822
C101	All except 682	0160-0819	Capacitor, Metal, 0.05 uf, 600v	Cornell-Dubilier	WMF-6S5
	682	NOT USED			

FIGURE 6-1. PARTS LIST (Sheet 1 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
C102	All except H02-680, 682	0180-0100	Capacitor, Tant, 4.7 uf, 35v	Sprague	150D475X90350-3
	Option 17 and H02-680	0180-0195	Capacitor, Tant, 0.33 uf, 35v	Sprague	150D334X00312
	682	NOT	USED		
C103	All except H02-680, 682	0180-0100	Capacitor, Tant, 4.7 uf, 35v	Sprague	150D475X90350-3
	H02-680 and Option 17	0180-0195	Capacitor, Tant, 0.33 uf, 35v	Sprague	150D334X00312
	682	NOT	USED		
C104	All except H02-680, 682	0180-0100	Capacitor, Tant, 4.7 uf, 35v	Sprague	150D475X90350-3
	H02-680 and Option 17	0180-0195	Capacitor, Tant, 0.33 uf, 35v	Sprague	150D334X00312
	682	NOT	USED		
C105	680, 681, 683	0160-2066	Capacitor, Metal, 0.022 uf, 200v	Electro Cube	Type 210B
	H01-680	0160-2088	Capacitor, Metal, 0.025 uf, 200v	Electro Cube	ECI-210B
	H02-680	0160-2067	Capacitor, Metal, 0.018 uf, 200v	Electro Cube	Type 210B
	Option 17	0160-2031	Capacitor, mica, 0.0036 uf, 500v		
	682	NOT	USED		
C200	All	0180-0324	Capacitor, Elect, 6 uf, 15v	Sprague	30D605G015BA4
C201	All	0180-0324	Capacitor, Elect, 6 uf, 15v	Sprague	30D605G015BA4
C202	All	0160-0157	Capacitor, Metal, 0.0047 uf 200v	Faradyne	MFD472K
C203	All except H02-680	0180-0320	Capacitor, Elect, 10 uf, 6v	Sprague	TE-1087
	H02-680 and Option 17	0180-0298	Capacitor, Elect, 25 uf, 3v	Sprague	
C204	All except H02-680	0160-0194	Capacitor, Metal, 0.015 uf, 200v	Faradyne	MFC153M
	H02-680 and Option 17	0160-2075	Capacitor, Metal, 0.047 uf, 100v	CD	SMF1547E
C205	All except H02-680	NOT	USED		
	H02-680 and Option 17	0180-0297	Capacitor, Elect, 4 uf, 12v	Sprague	30D405G012AA4
C206	All except H02-680	NOT	USED		
	H02-680 and Option 17	0180-0298	Capacitor, Elect, 25 uf, 3v	Sprague	30D256G-003BA4
C207	All except H02-680	NOT	USED		
	H02-680 and Option 17	0180-0320	Capacitor, Elect, 10 uf, 6v	Sprague	TE-1087
C208	All except H02-680	0180-0303	Capacitor, Elect, 100 uf, 3v	Sprague	TE-1059-5
	H02-680 and Option 17	0180-0298	Capacitor, Elect, 25 uf, 3v	Sprague	30D256G003BA4

FIGURE 6-1. PARTS LIST (Sheet 2 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
C209	All except H02-680	NOT	USED		
	H02-680 and Option 17	0180-0039	Capacitor, Elect, 100 uf, 12v	Sprague	30D107G012DC4
C210	All except H02-680	0180-0341	Capacitor, Elect, 25 uf, 10v	Sprague	TE-1118
	H02-680 and Option 17	0180-0324	Capacitor, Elect, 6 uf, 15v	Sprague	30D605G015BA4
C211	All	0180-0320	Capacitor, Elect, 10 uf, 6v	Sprague	TE-1087
C212	All	0180-0342	Capacitor, Elect, 250 uf, 6v	Sprague	TE-1105
C213	All	0180-0039	Capacitor, Elect, 100 uf, 12v	Sprague	TE-1135
C214	All	0180-0320	Capacitor, Elect, 10 uf, 6v	Sprague	TE-1087
C215	All	0180-0303	Capacitor, Elect, 100 uf, 3v	Sprague	TE-1059-5
C216	All	0180-0320	Capacitor, Elect, 10 uf, 6v	Sprague	TE-1087
C217	All	0160-0194	Capacitor, Metal, 0.015 uf, 200v	Faradyne	MFC153M
C218	All	0180-0340	Capacitor, Elect, 6 uf, 12v	Sprague	TE-1127
C301	All except 682, 683	0150-0119	Capacitor, dual, (2) 0.1 uf, 250v, 2%	Sprague	36C219A
	682, 683	NOT	USED		
C302	All	0180-0141	Capacitor, Elect, 50 uf, 50v	Sprague	TE-1307
C303	All	0180-0094	Capacitor, Elect, 100 uf, 25v	Sprague	TE-1211
C304	All	FACTORY	SELECTED CAPACITOR		
C400	Option 15	0180-1739	Capacitor, fxd alum, elec, 250 uf, +75 -10%	Sprague	390257-G050HE4
CR200	All except H02-680	NOT	USED		
	H02-680 and Option 17	1902-0057	Diode, Zener	Hoffman	Z3444
CR201	All	1910-0016	Diode	Transitron	T12G
CR202	All	1901-0022	Diode	Hewlett-Packard	1901-0022
CR203	All	1902-0768	Diode, Zener		PSI10074
CR204	All	1901-0157	Diode	Solitron	HC-30
CR205	All	1901-0157	Diode	Solitron	HC-30
CR206	All	1901-0157	Diode	Solitron	HC-30
CR207	All	1901-0157	Diode	Solitron	HC-30
CR300	All	1901-0158	Diode	Diodes, Inc	SD-2
CR301	All	1901-0158	Diode (Optional)	Diodes, Inc	SD-2
CR302	All	1901-0157	Diode	Solitron	HC-30
CR303	All	1901-0158	Diode	Diodes, Inc	SD-2
CR304	All	1901-0158	Diode	Diodes, Inc	SD-2
CR305	All	1901-0158	Diode	Diodes, Inc	SD-2
CR306	All	1901-0158	Diode	Diodes, Inc	SD-2
CR307	All	1910-0016	Diode	Hewlett-Packard	1910-0016
CR308	All	1910-0016	Diode	Hewlett-Packard	1910-0016
CR309	All	1902-0774	Diode, Zener	Int. Rec.	IN1513
CR310	All	1902-0774	Diode, Zener, 12.1v	Int. Rec.	IN1513

FIGURE 6-1. PARTS LIST (Sheet 3 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
CR311	All except 682	1902-0761	Diode, Zener	U.S. Semcor	IN429(or821)
	682	NOT	USED		
CR400	Option 15	1901-0191	Diode	Motorola	SR1358-2
CR401	Option 15	1901-0191	Diode	Motorola	SR1358-2
CR402	Option 15	1902-0670	Diode	Motorola	
CR403	Option 15	1902-0022	Diode	Motorola	SZ10939-16
CR404	Option 15	1902-0022	Diode	Motorola	SZ10939-16
DS100	Option 17	17999-19017	Light Block Assy	Hewlett-Packard	17999-19017
F300	All	2110-0018	Fuse, 1/4 amp		3AG SB
		2110-0064	Fuse, 1/8 amp		3AG SB
G200	All	1130-0002	Chopper	Airpax	Mod. 33
J100	All except 682	NOT	USED		
	682	1251-1186	Connector, Input		
J101	All except 682	1510-0008	Connector, Input (Red)	Hewlett-Packard	1510-0008
	682	NOT	USED		
J102	All except 682	1510-0009	Connector, Input (Black)	Hewlett-Packard	1510-0009
	682	NOT	USED		
J103	All except 682	1510-0009	Connector, Input (Black)	Hewlett-Packard	1510-0009
	682	NOT	USED		
J104	All	1251-1014	Connector	Winchester	JF1P-35
J105	Option 17	1251-1113	Connector	Winchester	JF1P-1S
J200	All	1251-0166	Connector	Amphenol	143-010-08
J300	All	1251-0406	Jack, remote pen	Tini Jax	#41
J301	All	1251-0406	Jack, event marker (optional)	Tini Jax	41
J302	All	1251-1113	Connector	Winchester	JF1P-1S
J303	All	8120-0078	Power Cord	Beldon	PH 151
J304	Option 09 All	1251-0406	Jack, Remote Chart Advance	Tini Jax	#41
J305	All	1251-0476	Connector	Amphenol	143-012
J306	All	1251-1113	Connector	Winchester	
J400	Option 15	1251-0166	Connector		
J401	Option 15	1251-1317	Connector	Winchester	JF1P-3S
K300	All	A11843	Coil-pen lift	Hewlett-Packard	A11843
K301	Optional All	A12251	Coil-event marker	Hewlett-Packard	A12251
P100	All except 682	NOT	USED		
	682	PART OF	P.C. BOARD		
P104	All	1251-1015	Connector	Winchester	JF3P-1S
P105	Option 17	1251-1113	Connector	Winchester	JF1P-1S
P200	All	PART OF	P.C. BOARD		
P302	All	1251-1113	Connector	Winchester	JF1P-1S
P303	All	1251-0148	Receptacle, Power	Tower	H1061-1G
P305	All	1251-1113	Connector	Winchester	JF1P-1S
P400	Option 15	PART OF	P.C. BOARD		
P401	Option 15	1251-1015	Connector	Winchester	JF1P-1S
Q200	All except H02-680	NOT	USED		
	H02-680 and Option 17	1850-0062	Transistor	RCA	2N404

FIGURE 6-1. PARTS LIST (Sheet 4 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
Q201	All except H02-680	1850-0154	Transistor	GE	2N508A
	H02-680 and Option 17	1850-0062	Transistor	RCA	2N404
Q202	All	1850-0154	Transistor	GE	2N508A
Q203	All	1850-0156	Transistor	Motorola	2N1370
Q204	All	1850-0156	Transistor	Motorola	2N1370
Q205	All	1854-0071	Transistor	Motorola	2N3391
Q206	All	1850-0076	Transistor	TI	2N1038-2
Q300	All	1850-0157	Transistor	Hewlett-Packard	1850-0157
Q400	Option 15	1854-0300	Transistor	Motorola	MJE 521
Q401	Option 15	1853-0073	Transistor	Motorola	MJE 371
Q402	Option 15	1853-0073	Transistor	Motorola	MJE 371
R100	680, 681, 682, 683	NOT	USED		
	H01-680	0811-0440	Resistor, Prec, ww, 800Ω, 0.1%	Cinema	CE543E
	H02-680	0811-0457	Resistor, Prec, ww, 50K, 0.1%	Cinema	CD542E
R101	680 and H01-680	0811-1233	Resistor, Prec, ww, 1K, 0.1%	Cinema	CE542E
	H02-680	0811-0378	Resistor, Prec, ww, 40K, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R102	680 and H01-680	0811-1517	Resistor, Prec, 8K, 0.1%	Cinema	CE542E
	H02-680	0811-0445	Resistor, Prec, ww, 5K, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R103	680 and H01-680	0811-0919	Resistor, Prec, 10K, 0.1%	Cinema	CE542E
	H02-680	0811-0377	Resistor, Prec, ww, 4K, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R104	680 and H01-680	0811-0459	Resistor, Prec, 80K, 0.1%	Cinema	CE542E
	H02-680	0811-0438	Resistor, Prec, ww, 500Ω, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R105	680 and H01-680	0811-0460	Resistor, Prec, 100K, 0.1%	Cinema	CE542E
	H02-680	0811-0436	Resistor, Prec, ww, 400Ω, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R106	680	0811-1249	Resistor, Prec, 800K, 0.1%	Cinema	CE543E
	H01-680	0811-0473	Resistor, Prec, ww, 1 meg, 0.1%	Cinema	CE542E
	H02-680	0811-0422	Resistor, Prec, ww, 50Ω, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		

FIGURE 6-1. PARTS LIST (Sheet 5 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
R107	680	0811-0473	Resistor, Prec, ww, 1 meg, 0.1%	Cinema	CE411E
	H01-680	0811-0422	Resistor, Prec, ww, 50 Ω, 0.1%	Cinema	CE542E
	H02-680	0811-0436	Resistor, Prec, ww, 40 Ω, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R108	680	0811-0433	Resistor, Prec, 249.89 Ω, 0.1%	Cinema	CE542E
	H01-680	0811-0419	Resistor, Prec, ww, 22.22 Ω, 0.1%	Cinema	CE542E
	H02-680	0811-0417	Resistor, Prec, ww, 5 Ω, 0.1%	Cinema	CE542E
	681, 682, 683	NOT	USED		
R109	680	0811-0429	Resistor, Prec, 11.06 Ω, 0.1%	Cinema	CE542E
	H01-680, 682, 683	NOT	USED		
	H02-680	0811-0417	Resistor, Prec, ww, 5 Ω, 0.1%	Cinema	CE542E
	681	SEE	FIGURE 6-3		
R110	680, H01-680 681, 683	0683-3615	Resistor, Comp, 360 Ω, 1/4w, 5%	Allen-Bradley	
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
	682	NOT	USED		
R111	680	0811-1233	Resistor, Prec, 1K, 0.1%	Cinema	CE542E
	H01-680	0811-0432	Resistor, Prec, ww, 200 Ω, 0.1%	Cinema	CE542E
	H02-680	0684-1531	Resistor, Comp, 15K, 1/4w, 10%	Allen-Bradley	
	681	SEE	FIGURE 6-3		
	682	NOT	USED		
	683	FACTORY	SELECTED		
R112	All except H02-680	NOT	USED		
	H02-680	0683-1835	Resistor, Comp, 18K, 1/4w, 5%	Allen-Bradley	
R113	All except H02-680	NOT	USED		
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R114	All except H02-680	NOT	USED		
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R115	All except H02-680	NOT	USED		
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R116	All except H02-680	NOT	USED		
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R117	All except H02-680	NOT	USED		
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	

FIGURE 6-1. PARTS LIST (Sheet 6 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
R118	All except H02-680	NOT	USED		
	H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R119	680 except metric	0757-0415	Resistor, Carbon, 475Ω, 1/8w, 1%	Electra	MF5CD4750F
	680M	0684-5611	Resistor, Comp, 560Ω, 1/4w, 5%	Allen-Bradley	
	H01-680 except metric	0757-0401	Resistor, Carbon, 100Ω, 1%	Allen-Bradley	
	H01-680M	0811-1329	Resistor, Prec, ww, 120Ω, 1%	Allen-Bradley	
	H02-680 except metric and 683	0757-0415	Resistor, Carbon, 475Ω, 1/8w, 1%	Electra	MF5CD4750F
	H02-680M	0698-3253	Resistor, Carbon, 560Ω, 1/8w, 1%	Electra	MF5C-CB481C
	681	SEE	FIGURE 6-3		
	682	NOT	USED		
R120	All except 682	0757-0481	Resistor, Carbon, 475K, 1/8w, 1%	Electra	MF5CD4753F
	682	NOT	USED		
R121	All except 682	2100-0407	Resistor, Var, 5K, ±10%	CT	Type 252
	682	NOT	USED		
R122	680, 681, 683, H01-680	0683-3615	Resistor, Comp, 360Ω, 1/4w, 5%	Allen-Bradley	
	H02-680 and Option 17	0684-1021	Resistor, Prec, 1K, 1/4w, 10%	Allen-Bradley	
	682	NOT	USED		
R123	680, 681, 683 H01-680	0683-3615	Resistor, Comp, 360Ω, 1/4w, 5%	Allen-Bradley	
	H02-680 and Option 17	0684-1021	Resistor, Prec, 1K, 1/4w, 10%	Allen-Bradley	
	682	NOT	USED		
R124	680 except metric Option 17	0811-0994	Resistor, Prec, ww, 1K, 1%	Cinema	B11E
		0811-1293	Resistor, Prec, ww, 5K, 0.1%	Kelvin	KP101
	H01-680 except metric	0811-0432	Resistor, Prec, ww, 200Ω, 0.1%	Cinema	CE542E
	H01-680M	0811-0479	Resistor, Prec, ww, 250Ω, 1%	Cinema	CE542E
	H02-680 except metric and 683	0811-0994	Resistor, Prec, ww, 1K, 1%	Cinema	B11E
	680M H02-680M	0811-0483	Resistor, Prec, ww, 1.2K, 1%	Cinema	CE542E
	681	SEE	FIGURE 6-3		
	682	NOT	USED		
R125	All except 682 and Option 17	0698-3267	Resistor, Carbon, 750K, 1/2w, 1%	Electra	MF7C-E-7503F
	682	NOT	USED		
	Option 17	0698-3587	Resistor, Carbon, 5 meg, 1/2%	Electra	MF5C-D-4753

FIGURE 6-1. PARTS LIST (Sheet 7 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
R126	All except H02-680	NOT	USED		
	H02-680	0684-1041	Resistor, Comp, 100K, 1/4w, 10%	Allen-Bradley	
R127	All models except metric and 682	0811-0484	Resistor, Prec, ww, 1.5K, 0.1%	Cinema	CE542E
	All metric models except 682	0811-0376	Resistor, Prec, ww, 2.5K, 1%	Cinema	CE542E
	Option 17 and 682	NOT	USED		
R128	All except 682	2100-1416	Resistor, Var, 1K, ±20%	CT	BK12449
	682	NOT	USED		
R129	All except Option 17	M10082	Resistor, slidewire, 5K	Hewlett-Packard	
	Option 17	17999-19063	Photo Slidewire Assy	Hewlett-Packard	
R130	Option 17	0811-2147	Resistor, Fxd, 70 Ω, 1w	Allen-Bradley	
R200	All	0686-4315	Resistor, Comp, 430 Ω, 1/2w, 5%	Allen-Bradley	
R201	All except H02-680	0683-2435	Resistor, Comp, 24K, 1/4w, 5%	Allen-Bradley	
	H02-680 and Option 17	0683-1025	Resistor, Comp, 1K, 1/4w, 5%	Allen-Bradley	
R202	All except H02-680	NOT	USED		
	H02-680 and Option 17	0684-2731	Resistor, Comp, 27K, 1/4w, 10%	Allen-Bradley	
R203	All except H02-680	NOT	USED		
	H02-680 and Option 17	0683-1025	Resistor, Comp, 1K, 1/4w, 5%	Allen-Bradley	
R204	All except H02-680	NOT	USED		
	H02-680 and Option 17	0684-3921	Resistor, Comp, 3.9K, 1/4w, 10%	Allen-Bradley	
R205	All except H02-680	NOT	USED		
	H02-680 and Option 17	0684-8231	Resistor, Comp, 82K, 1/4w, 10%	Allen-Bradley	
R206	All	0684-2731	Resistor, Comp, 27K, 1/4w, 10%	Allen-Bradley	
R207	All except H02-680	NOT	USED		
	H02-680 and Option 17	0683-6225	Resistor, Comp, 6.2K, 1/4w, 5%	Allen-Bradley	
R208	All except H02-680	NOT	USED		
	H02-680 and Option 17	0684-1011	Resistor, Comp, 100 Ω, 1/4w, 10%	Allen-Bradley	
R209	All except H02-680	0684-4721	Resistor, Comp, 4.7K, 1/4w, 10%	Allen-Bradley	
	H02-680 and Option 17	0683-1135	Resistor, Comp, 11K, 1/4w, 5%	Allen-Bradley	
R210	All except H02-680	NOT	USED		
	H02-680 and Option 17	0683-1025	Resistor, Comp, 1K, 1/4w, 5%	Allen-Bradley	

FIGURE 6-1. PARTS LIST (Sheet 8 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
R211	All except H02-680	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
	H02-680 and Option 17	0683-2035	Resistor, Comp, 20K, 1/4w, 5%	Allen-Bradley	
R212	All except H02-680	NOT	USED		
	H02-680 and Option 17	0684-1231	Resistor, Comp, 12K, 1/4w, 10%	Allen-Bradley	
R213	All	0684-4721	Resistor, Comp, 4.7K, 1/4w, 10%	Allen-Bradley	
R214	All except H02-680	0684-0145	Resistor, Comp, 1K, 1/4w, 10%	Allen-Bradley	
	H02-680 and Option 17	0684-4711	Resistor, Comp, 470 Ω, 1/4w, 10%	Allen-Bradley	
R215	All	0684-8221	Resistor, Comp, 8.2K, 1/4w, 10%	Allen-Bradley	
R216	All	0683-6235	Resistor, Comp, 62K, 1/4w, 10%	Allen-Bradley	
R217	All	0684-1011	Resistor, Comp, 100 Ω, 1/4w, 10%	Allen-Bradley	
R218	All	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R219	All	0684-5621	Resistor, Comp, 5.6K, 1/4w, 10%	Allen-Bradley	
R220	All	0684-5621	Resistor, Comp, 5.6K, 1/4w, 10%	Allen-Bradley	
R221	All	0684-1521	Resistor, Comp, 1.5K, 1/4w, 10%	Allen-Bradley	
R222	All	0684-2231	Resistor, Comp, 22K, 1/4w, 10%	Allen-Bradley	
R223	All	2100-0093	Resistor, Var, 20K, 1/4w, 30%	CTS	UPE-70
R224	All	0683-6235	Resistor, Comp, 62K, 1/4w, 10%	Allen-Bradley	
R225	All	0684-2221	Resistor, Comp, 2.2K, 1/4w, 10%	Allen-Bradley	
R226	All	0684-2221	Resistor, Comp, 2.2K, 1/4w, 10%	Allen-Bradley	
R227	All	0684-6801	Resistor, Comp, 68 Ω, 1/4w, 10%	Allen-Bradley	
R228	All	0683-1135	Resistor, Comp, 11K, 1/4w, 5%	Allen-Bradley	
R229	All	0683-1025	Resistor, Comp, 1K, 1/4w, 5%	Allen-Bradley	
R230	All	0684-2201	Resistor, Comp, 22 Ω, 1/4w, 10%	Allen-Bradley	
R231	All	0684-1031	Resistor, Comp, 10K, 1/4w, 10%	Allen-Bradley	
R232	All	0684-6801	Resistor, Comp, 68 Ω, 1/4w, 10%	Allen-Bradley	

FIGURE 6-1. PARTS LIST (Sheet 9 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
R300	All	0813-0050	Resistor, Non-prec, ww, 100 Ω, 3w	Sprague	242E-1015
R301	All	0813-0050	Resistor, Non-prec, ww, 100 Ω, 3w	Sprague	242E-1015
R302	All	0684-2721	Resistor, Comp, 2.7K, 1/4w, 10%	Allen-Bradley	
R303	All	0684-2211	Resistor, Comp, 220 Ω, 1/4w, 10%	Allen-Bradley	
R304	All	0684-1821	Resistor, Comp, 1.8K, 1/4w, 10%	Allen-Bradley	
R305	All	0684-2211	Resistor, Comp, 220 Ω, 1/4w, 10%	Allen-Bradley	
R306	All except 682	0684-4711	Resistor, Comp, 470 Ω, 1/4w, 10%	Allen-Bradley	
	682	NOT	USED		
R400	Option 15	0686-8215	Resistor, fxd, comp, 820 Ω, 1/2w, 5%	Allen-Bradley	
R401	Option 15	0686-2405	Resistor, Comp, 24 Ω, 5%, 1/2w	Allen-Bradley	
R402	Option 15	0812-0043	Resistor, fxd, 100 Ω, 1w, ±3%		
R403	Option 15	0811-2469	Resistor, fxd, 1.2K, 1w, 1%	Dale	RS1A
R404	Option 15	0686-4705	Resistor, Comp, 47 Ω, 1/4w, 5%	Allen-Bradley	
R405	Option 15	0813-0050	Resistor, fxd, ww, 100 Ω, 3w, 5%	Sprague	242E
R406	Option 15	0811-2469	Resistor, fxd, 1.2K, 1w, 1%	Dale	RS1A
S101	680 and H01-680, H02-680	3100-1574	Switch, Attenuator	Centralab	PA2000 SER
	H01-680	M11872	Complete Atten. Switch Assy	Hewlett-Packard	
	680	M10074	Complete Atten. Switch Assy	Hewlett-Packard	
	681, 682, 683	NOT	USED		
S300	All	3101-0158	Switch, Interlock	Switchcraft	
S301	All	3101-0062	Switch, Pen lift	Hetherington	T-3103
S302	All	3101-0062	Switch, Power	Hetherington	T-3103
S303	All	3101-0033	Switch, Power conversion	Hewlett-Packard	3101-0033
T200	All except H02-680	9100-1526	Transformer, Input	McCarron	M2064
	H02-680 and Option 17	9100-1532	Transformer, Input	Triad	G-95052
T300	All	1850-0157	Transformer, Power	Ferrodyne	6028
T400	Option 15	9100-2431	Transformer, Power	Topaz	61128
			MISCELLANEOUS		
		A-11171	Event Marker Coil (Up to S/N 360)	Hewlett-Packard	
		A-12251	Event Marker Coil (S/N 361 and Up)	Hewlett-Packard	
		M-18688	Event Marker Kit	Hewlett-Packard	

FIGURE 6-1. PARTS LIST (Sheet 10 of 11)

Circuit Symbol	Model Used On	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfr. Part No.
		A-12482	Pen Scale, Metric (S/N 1976 and Up)	Hewlett-Packard	
		A-12482-F	Pen Scale, Metric (Up to S/N 1976)	Hewlett-Packard	
		A-13002	Dual Rack Adapter with Glass Door	Hewlett-Packard	
		A-15126	Pen Cleaning Wire	Hewlett-Packard	
		A-15448	Dual Rack Adapter (Open Type)	Hewlett-Packard	
		B-9638	Pen Scale, Standard (SN 1976 and UP)	Hewlett-Packard	
		B-9638-F	Pen Scale, Standard (Up to (S/N 1976)	Hewlett-Packard	
		M-16897	Pressure Sensitive to Ink (Conversion Kit)	Hewlett-Packard	
		M-18547	Accessory Kit (Ink)	Hewlett-Packard	
		A-18371	Stylus (Pressure Sensitive)	Hewlett-Packard	
			CHART PAPER AND INK SUPPLIES		
		9270-1012	Standard Roll Chart Paper	Hewlett-Packard	
		9270-1018	Hour Markings Every 4"	Hewlett-Packard	
		9270-1074	Electo Sensitive Paper	Hewlett-Packard	
		9270-1025	Matric Roll Chart Paper	Hewlett-Packard	
		9270-1033	Standard Pressure Sensitive Paper (Red Trace)	Hewlett-Packard	
		9270-1045	Metric Pressure Sensitive Paper (Red Trace)	Hewlett-Packard	
		1530-0095	Ink Cartridge, Blue	Hewlett-Packard	
		1530-0703	Ink Cartridge, Red	Hewlett-Packard	
		1530-0704	Ink Cartridge, Green	Hewlett-Packard	
		1530-0984	Ink Cartridge, Purple	Hewlett-Packard	
		1530-0905	Ink Cartridge, Black	Hewlett-Packard	
		1530-0775	Spool, Paper	Hewlett-Packard	
		0890-0349	Plastic Tubing (From Primer)	Alphlex	#PVC-105/5
		0890-0351	Plastic Tubing (Ink Line)	Esterbrook	Extra Flex Vinyl

FIGURE 6-1. PARTS LIST (Sheet 11 of 11)

ONE YEAR ISOLATED SPARE PARTS			
Hewlett-Packard Part No.	Description	Mfr. Designation	RS
A-9692	Spring, 60:1 lever	Hewlett-Packard	1
A-10073	Gear Plate, With 2 to 1 reduction gears	Hewlett-Packard	1
A-10074	Attenuator Assembly	Hewlett-Packard	1
M-18464	Pen Assembly	Hewlett-Packard	2
A-10082	Slidewire	Hewlett-Packard	1
A-10194	Spring, Pen holddown	Hewlett-Packard	2
A-10351	Ring, Clutch pressure	Hewlett-Packard	1
A-10534	Cartridge Holder	Hewlett-Packard	1
A-10561	Spring, Tension (Fig. 4-6)	Hewlett-Packard	2
A-10678	Spring, Nylon cord	Hewlett-Packard	2
A-10822	Motor, DC servo	Hewlett-Packard	1
A-10824	60:1 Speed Changer (Epicyclic Gear Assembly)	Hewlett-Packard	1
A-11641	Spring, Pen lift solenoid	Hewlett-Packard	2
A-11843	Solenoid, Pen lift	Hewlett-Packard	1
B-9572	Slider Block	Hewlett-Packard	1
B-9585	Wiper Contact	Hewlett-Packard	2
M-10500	Lever, Gear shift	Hewlett-Packard	1
1850-0157	Transformer, Power	Ferodyne 6028	1
9100-1526	Transformer, Input	McCarron M2064	1
1530-0020	Chain, Chart magazine drive (0.123)	Bohannon Industries	1 ft.
0900-0017	Ring, "O" chart magazine	Parker #2-9 (N219-7)	2
1530-0764	Chain, Beaded (105 beads) Type 3	Voland & Sons	1
1530-0765	Chain, Beaded (110 beads) Type 3	Voland & Sons	1
1130-0002	Chopper	Airpax Mod. 33	1
8160-0050	Cord, Nylon Type 75	General Cement	3 ft.
3140-0060	Motor, Chart drive	Cramer Controls	1
9270-1012	Chart Paper	Gubelman #GLR-12	As Req'd
2100-0407	Variable Resistor, 5K zero pot.	CTC Spec 39346	2
1910-0016	Diode	Transitron #T12G	2
1902-0761	Diode	I.R. #31142	2
1901-0158	Diode	Diodes, Inc. #SD-2	
1850-0156	Transistor	Motorola 2N1370	2
1851-0025	Transistor	T.I. 2N1306	2
1850-0154	Transistor	G. E. 2N508A	2
1854-0033	Transistor	G. E. 2923	2
3101-0062	Switch, Power and pen lift	Hetherington T3103	1
8120-0078	Power Cord, 7.5 ft	Belden #PH151	1
2110-0018	Fuse, 1/4 amp, 115 v, 3 AG	Littlefuse	10
1530-0095	Ink Cartridge (Blue)	Esterbrook #40-8B	As Req'd
1530-0096	Primer Bulb	Esterbrook #40-80-0611-11	2
1410-0276	Pulley, Return	Kilian #SR-180-6	2
0890-0349	Tubing, Plastic (primer line)	Alphlex PVC-105/5	2 ft.
0890-0351	Tubing, Plastic (ink line)	Esterbrook - Vinyl	2 ft.
8500-0257	Slidewire Lubricant and Cleaner	Hewlett-Packard	2

FIGURE 6-2. RECOMMENDED SPARE PARTS LIST (Sheet 1 of 2)

FOR 50 CYCLE OPERATION			
Hewlett-Packard Part No.	Description	Mfr. Designation	RS
3140-0213	Chart Motor,	Cramer Controls	1
2110-0064	Fuse, 1/8 amp, 115 v, 3 AG	Littlefuse	10
	RUNNING SPARES		
A-9692	Spring, 60:1 lever	Hewlett-Packard	1
M18464	Pen Assembly	Hewlett-Packard	1
M10082	Slidewire	Hewlett-Packard	1
A-10194	Spring, Pen holddown	Hewlett-Packard	1
A-10561	Spring, Tension	Hewlett-Packard	1
A-10678	Spring, Nylon cord	Hewlett-Packard	1
A-10822	Motor, DC	Hewlett-Packard	1
M18112	60:1 Speed Changer (Epicyclic Gear)	Hewlett-Packard	1
A-11641	Spring, Pen lift solenoid	Hewlett-Packard	1
A-11843	Solenoid, Pen lift	Hewlett-Packard	1
B-9585	Wiper Contact	Hewlett-Packard	1
1130-0002	Chopper 5080-7930	Airpax Mod. 33	1
8160-0050	Cord, Nylon	General Cement	3 ft.
2110-0018	Fuse, 1/4 amp, 115 v, 3 AG	Littlefuse	5
1530-0096	Primer Bulb	Esterbrook #40-80-0611-11	1
0890-0349	Tubing, Plastic	Alphlex PVC 105/5	1 ft.
0890-0351	Tubing, Plastic	Esterbrook Vinyl	1 ft.
5080-3635	Slidewire Lubricant	Hewlett-Packard	1
5080-3605	Slidewire, Cleaner	Hewlett-Packard	1

FIGURE 6-2. RECOMMENDED SPARE PARTS LIST (Sheet 2 of 2)

Circuit Symbol	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
		5 MV RANGE		
R-109		NOT USED		
R-111	0811-0994	Resistor, Prec, ww, 1K, 1%	Cinema	CE 542E
R-119	0684-4711	Resistor, Comp, 470Ω, 1/4 w, 10%	Allen-Bradley	
R-124	0811-0994	Resistor, Prec, ww, 1K, 1%	Cinema	CE 542E
		10 MV RANGE		
R-109		NOT USED		
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES IN 681/681M (Sheet 1 of 4)

Circuit Symbol	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
		50 MV RANGE		
R-109	0811-1265	Resistor, Prec, ww, 8K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
		100 MV RANGE		
R-109	0811-1266	Resistor, Prec, ww, 18K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
		500 MV RANGE		
R-109	0811-1267	Resistor, Prec, ww, 98K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
		1V RANGE		
R-109	0811-1268	Resistor, Prec, ww, 198K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
		5V RANGE		
R-109	0757-0258	Resistor, Carbon, 1M, 1%	Allen-Bradley	
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
		10V RANGE		
R-109	0698-3276	Resistor, Carbon, 2 meg, 1%	Allen-Bradley	
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
		50V RANGE		
R-109	0698-3276	Resistor, Carbon, 2MΩ, 1%	Allen-Bradley	
R-111	0811-1270	Resistor, Prec, ww, 400Ω, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K ohms, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2K Ω, 1%	Cinema	CE 542E
		100V RANGE		
R-109	0698-3276	Resistor, Carbon, 2 Meg, 1%	Allen-Bradley	
R-111	0811-0477	Resistor, Prec, ww, 200Ω, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1KΩ, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1262	Resistor, Prec, ww, 2KΩ, 1%	Cinema	CE 542E
		1.2 MV RANGE		
R-111	0811-0477	Resistor, Prec, ww, 200Ω, 1%		
R-119	0684-1011	Resistor, Comp, 100Ω, 1/4 w, 10%		
R-124	0811-0477	Resistor, Prec, ww, 200Ω, 1%		

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES IN 681/681M (Sheet 2 of 4)

Circuit Symbol	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
		6MV RANGE		
R-109		NOT USED		
R-111	0811-0994	Resistor, Prec, ww, 1K, 1%	Cinema	CE 542E
R-119	0684-4711	Resistor, Comp, 470 Ω, 1/4 w, 10%	Allen-Bradley	
R-124	0811-0994	Resistor, Prec, ww, 1K, 1%	Cinema	CE 542E
		12 MV RANGE		
R-109		NOT USED		
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		60 MV RANGE		
R-109	0811-1265	Resistor, Prec, ww, 8K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		120 MV RANGE		
R-109	0811-1266	Resistor, Prec, ww, 18K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		600 MV RANGE		
R-109	0811-1267	Resistor, Prec, ww, 98K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		1.2 V RANGE		
R-109	0811-1268	Resistor, Prec, ww, 198K, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		6 V RANGE		
R-109	0811-1269	Resistor, Prec, ww, 1M, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		12 V RANGE		
R-109	0811-1271	Resistor, Prec, ww, 2M, 1%	Cinema	CE 542E
R-111	0811-0262	Resistor, Prec, ww, 2K, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES IN 681/681M (Sheet 3 of 4)

Circuit Symbol	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
		60 V RANGE		
R-109	0811-1271	Resistor, Prec, ww, 2M, 1%	Cinema	CE 542E
R-111	0811-1262	Resistor, Prec, ww, 500 ohm, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E
		120 V RANGE		
R-109	0811-1271	Resistor, Prec, ww, 2M, 1%	Cinema	CE 542E
R-111	0811-1277	Resistor, Prec, ww, 222 ohm, 1%	Cinema	CE 542E
R-119	0683-1025	Resistor, Comp, 1K, 1/4 w, 5%	Allen-Bradley	
R-124	0811-1279	Resistor, Prec, ww, 2.4K, 1%	Cinema	CE 542E

FIGURE 6-3. FACTORY SELECTED RESISTORS FOR VARIOUS RANGES IN 681/681M (Sheet 4 of 4)

Circuit Symbol	Hewlett-Packard Part No.	Description	Typical Mfr.	Mfrs. Part No.
		60 CPS		
	3140-0060	Motor - 1 IN/MIN and 1 IN/HR		
	3140-0060	Motor - 2 IN/MIN and 2 IN/HR		
	3140-0060	Motor - 4 IN/MIN and 4 IN/HR		
	3140-0060	Motor - 8 IN/MIN and 8 IN/HR		
	D-13665	Motor - 15 IN/MIN and 15 IN/HR		
	D-13666	Motor - 30 IN/MIN and 30 IN/HR		
	D-13667	Motor - 60 IN/MIN and 60 IN/HR		
		50 CPS		
	3140-0061	Motor - 1 IN/MIN and 1 IN/HR		
	3140-0061	Motor - 2 IN/MIN and 2 IN/HR		
	3140-0061	Motor - 4 IN/MIN and 4 IN/HR		
	3140-0061	Motor - 8 IN/MIN and 8 IN/HR		
	D-13665	Motor - 12-1/2 IN/MIN and 12-1/2 IN/HR		
	D-13666	Motor - 25 IN/MIN and 25 IN/HR		
	D-13667	Motor - 50 IN/MIN and 50 IN/HR		

FIGURE 6-4. CHART DRIVE MOTOR

SECTION VII
CIRCUIT DIAGRAMS AND COMPONENT IDENTIFICATION

7-1. INTRODUCTION

7-2. This section contains mechanical parts identification (exploded views), and component location photos accompanied by the appropriate circuit diagram.

7-3. MECHANICAL PARTS IDENTIFICATION

7-4. A thorough breakdown of mechanical and electromechanical components is provided in figures 7-2 through 7-5. These illustrations are useful for parts identification and assembly/disassembly information.

7-5. CIRCUIT DIAGRAMS

7-6. Figures next to schematics are component location photos that show the physical location of each component. They accompany the appropriate schematic.

Item	Part No.	Description	Qty	Item	Part No.	Description	Qty
1	A9423	Syringe	1 each				
2	A15126	Pen Cleaning Wire	1 each	6	5080-3635	Slidewire Lubricant	1 Bottle
3	1530-0095	Ink Cartridge - Blue	4 each	7	5080-3605	Slidewire Cleaner	1 Can
4	1530-0703	Ink Cartridge - Red	4 each	8	9211-0343	Plastic Box	1 each
5	1251-0405	"Tini-Plug" #750	1 each	9	M18464	Pen Assembly	1 each

FIGURE 7-1. ACCESSORY KIT (M18547)

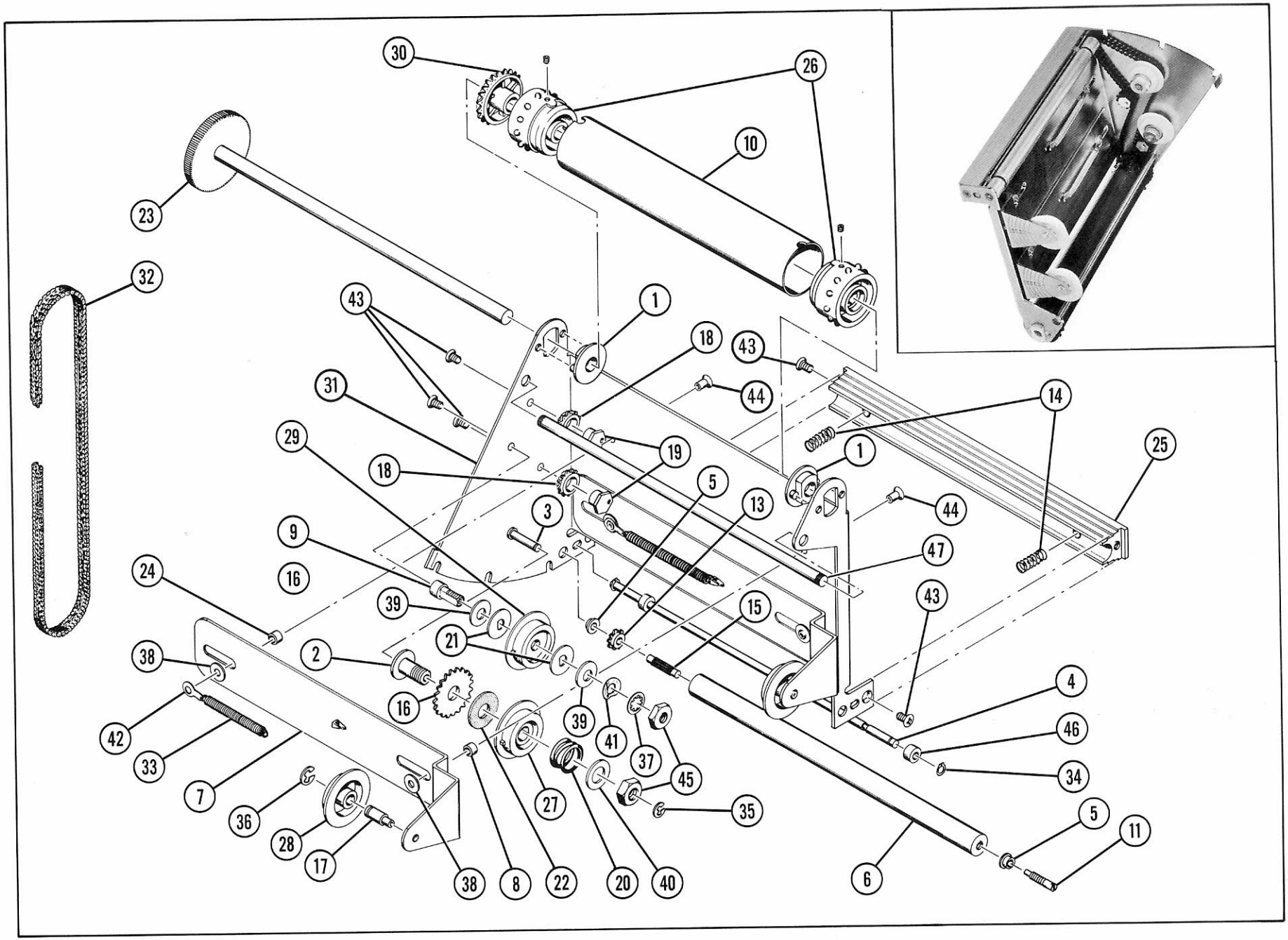


FIGURE 7-2. EXPLODED VIEW OF CHART MAGAZINE (Sheet 1 of 2)

CHART MAGAZINE ASSEMBLY - P/N M10064

LEGEND FOR FIGURE 7-2

Item	Part No.	Description	Mfr Designation
1	A-9554	Bushing, Pivot	Hewlett-Packard
2	A-9555	Bearing, Clutch	Hewlett-Packard
3	A-9557	Shaft	Hewlett-Packard
4	A-9559	Roller, Tension	Hewlett-Packard
5	A-9561	Bushing	Hewlett-Packard
6	M-10070	Roller Assy	Hewlett-Packard
7	A-9568	Bracket, Slide	Hewlett-Packard
8	A-9570	Spacer	Hewlett-Packard
9	A-9626	Stud	Hewlett-Packard
10	A-9628	Drum	Hewlett-Packard
	17999-19711	Drum (Metric)	Hewlett-Packard
11	A-9744	Shaft	Hewlett-Packard
12	A-9772	Rod, Paper Guide	Hewlett-Packard
13	A-9839	Sprocket	Hewlett-Packard
14	A-16825	Spring	Hewlett-Packard
15	A-10372	Shaft	Hewlett-Packard
16	A-10375	Sprocket, Take-up	Hewlett-Packard
17	A-10431	Stud	Hewlett-Packard
18	A-10447	Sprocket, Idler	Hewlett-Packard
19	A-10448	Bushing, Adjustment	Hewlett-Packard
20	A-10451	Spring, Clutch	Hewlett-Packard
21	A-10624	Washer	Hewlett-Packard
22	A-10978	Disc, Take-up	Hewlett-Packard
23	A-11255	Drum Shaft Assy	Hewlett-Packard
24	A-13893	Spacer	Hewlett-Packard
25	B-9558	Handle, Magazine	Hewlett-Packard
26	B-9869	Sprocket	Hewlett-Packard
	5040-3104	Sprocket, LH (Metric)	
	5020-4230	Sprocket, RH (Metric)	
27	B-10336	Hub, Take-up	Hewlett-Packard
28	B-10338	Hub	Hewlett-Packard
29	B-10339	Hub	Hewlett-Packard
30	B-10729	Sprocket	Hewlett-Packard
31	C-9614	Frame	Hewlett-Packard
32	1530-0020	Chain (12")	Hewlett-Packard
33	1460-0190	Spring	
34	0510-0082	Retainer, Ring	Tru-Arc
35	0510-0015	Retainer, Ring	Tru-Arc
36	0510-0263	Retainer, Ring	Tru-Arc
37	2190-0011	Washer	
38	360-0030	Washer, #4	
39	3050-0226	Washer	
40	2190-0152	Washer, Flat	
41	2190-0155	Washer	
42	0360-0073	Solder Lug	
43	2200-0056	Screw	
44	0361-0208	Rivet	
45	2740-0002	Nut, 10-32	
46	1410-0257	Bushing	
47	A-9772	Rod, Paper Guide	Hewlett-Packard

FIGURE 7-2. EXPLODED VIEW OF CHART MAGAZINE (Sheet 2 of 2)

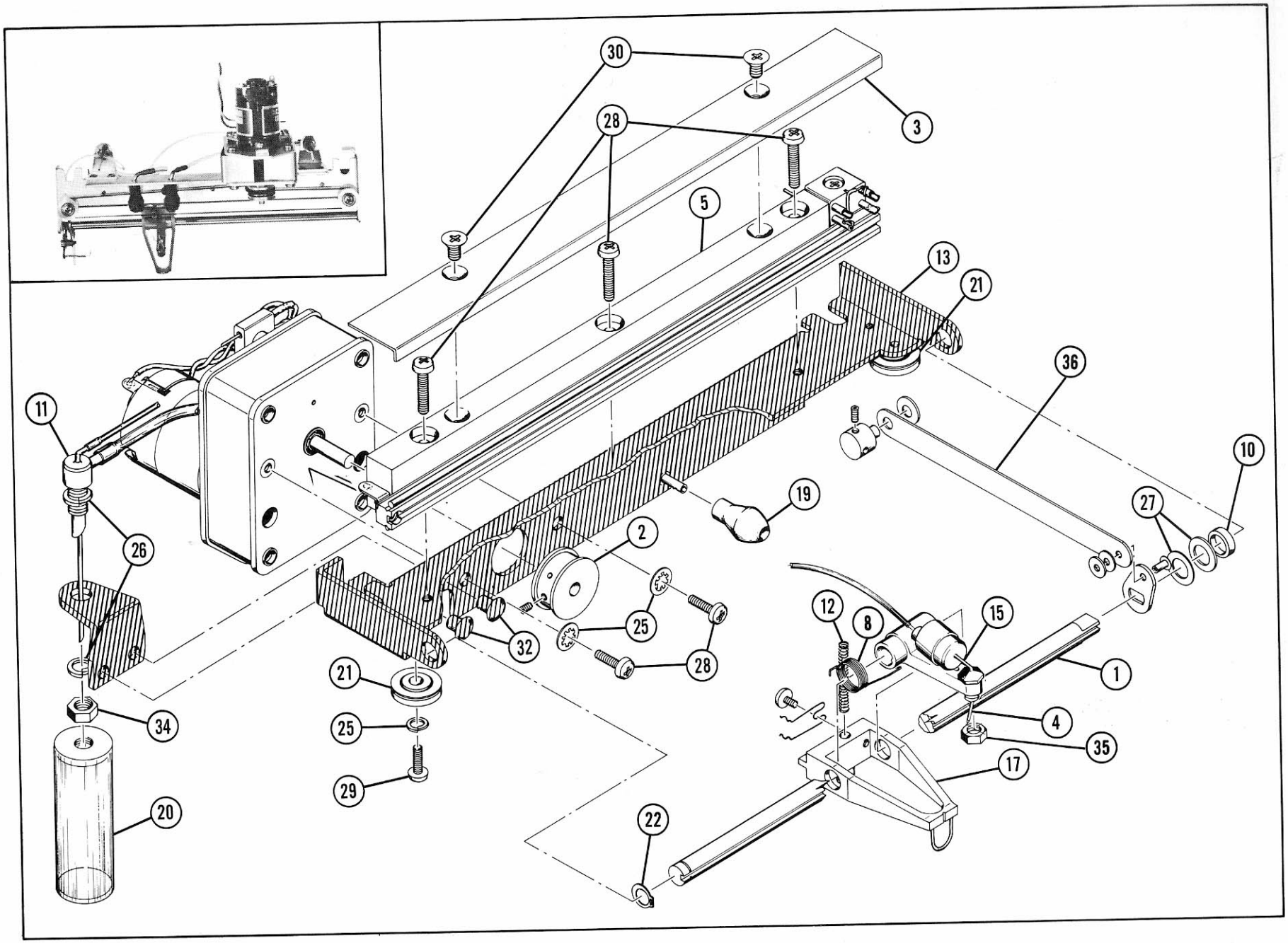


FIGURE 7-3. EXPLODED VIEW OF PEN CARRIAGE (Sheet 1 of 2)

LEGEND FOR FIGURE 7-3

Item	Part No.	Description	Mfr Designation
1	A9548	Rod	Hewlett-Packard
2	A9699	Sheave	Hewlett-Packard
3	A9706	Cover	Hewlett-Packard
4	M-18464	Pen Tip	Hewlett-Packard
5	A10082	Potentiometer Assy	Hewlett-Packard
8	A10194	Spring, Holddown	Hewlett-Packard
10	A10533	Spacer	Hewlett-Packard
11	A10586	Holder, Ink Cartridge	Hewlett-Packard
12	A10678	Spring, Tension	Hewlett-Packard
13	17999-19055	Bracket Assy	Hewlett-Packard
15	A18368	Holder, Pen	Hewlett-Packard
17	17999-14106	Slider Block Assy	Hewlett-Packard
19	1530-0096	Bulb	
20	1530-0703	Ink Cartridge (Red)	Hewlett-Packard
21	1410-0276	Ball Bearing	
22	0510-0238	Ring Retaining	
25	2190-0108	Washer, Split	
26	2190-0087	Washer, Split	
27	2190-0181	Washer	
28	2200-0049	Screw	
29	2270-0020	Screw	
30	2200-0056	Screw, Flat Head	
34	2580-0002	Nut, 8-32 x 1/4	
35	0540-0003	Nut, 5-40	
36	A10681	Pen Lift Arm Assy	Hewlett-Packard

FIGURE 7-3. EXPLODED VIEW OF PEN CARRIAGE (Sheet 2 of 2)

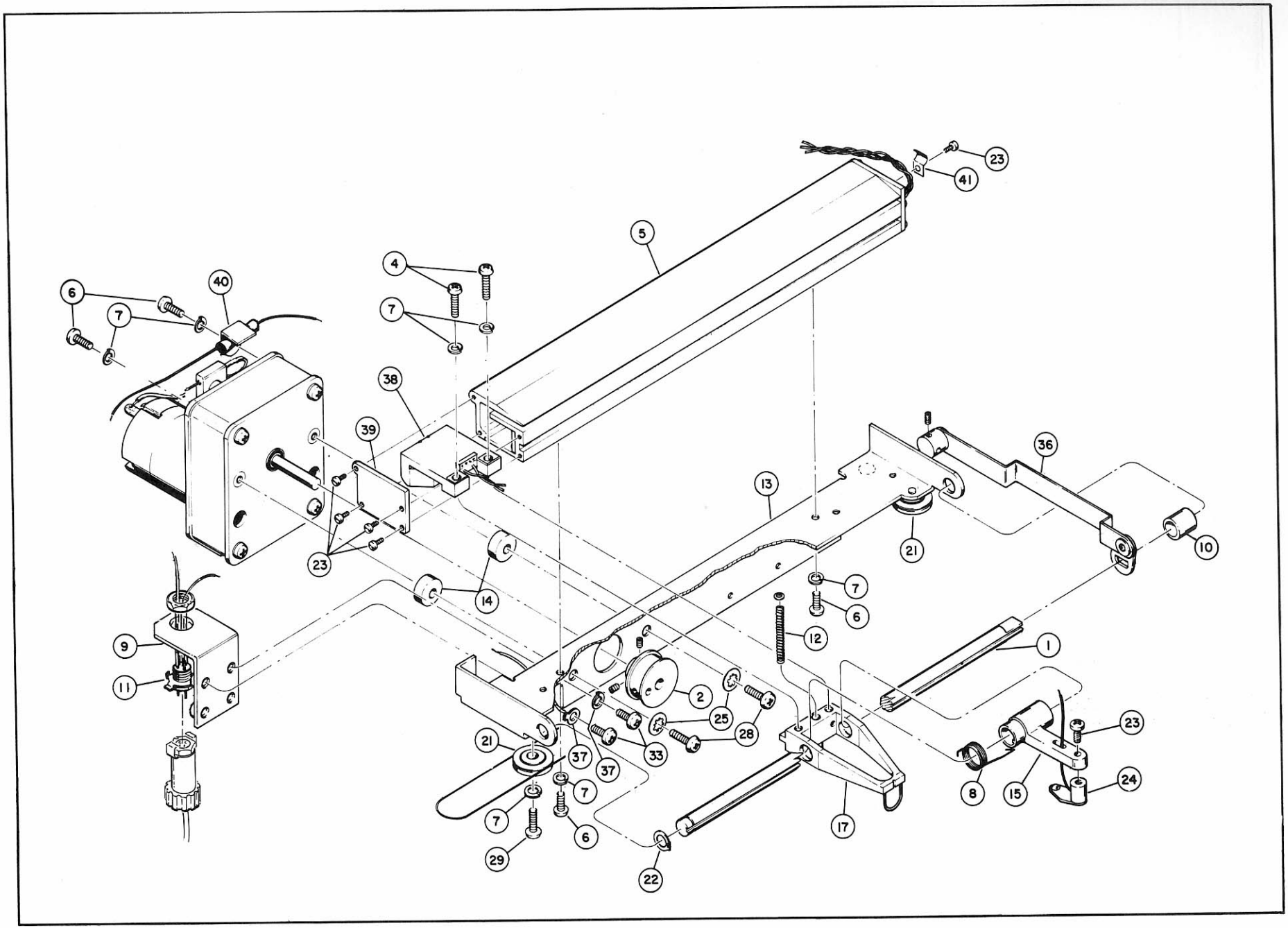


FIGURE 7-4. EXPLODED VIEW OF PEN CARRIAGE WITH ELECTRIC STYLUS AND PHOTO SLIDEWIRE (Sheet 1 of 2)

LEGEND FOR FIGURE 7-4

Item	Part No.	Description	Mfr Designation
1	A9548	Rod	
2	A9699	Sheave	
3		Not Used	
4	0520-0083	Screw, 2-56 x 7/16	
5	17999-19063	Photo-slidewire Assy (Complete)	
6	0520-0066	Screw, 2-56 x 3/16	
7	2190-0112	Washer, Lock	
8	A10194	Spring, Holddown	
9	17999-19576	Bracket, Connector	
10	17999-19022	Spacer	
11	1251-1316	Connector	
12	A10678	Spring, Tension	
13	A10679	Bracket Assy	
14	0380-0134	Spacer, Motor	
15	17999-10899	Stylus Holder	
16		Not Used	
17	17999-19057	Guard Assy, Pen	
18		Not Used	
19		Not Used	
20		Not Used	
21	1410-0276	Ball Bearing	
22	0510-0238	Ring, Retaining	
23	0570-0030	Screw, 0-80	
24	17999-19657	Electric Stylus Assy	
25	2190-0108	Washer, Split	
26		Not Used	
27		Not Used	
28	2200-0049	Screw	
29	2270-0020	Screw	
30		Not Used	
31		Not Used	
32		Not Used	
33	0570-0125	Screw, 4-40 x 3/16	
34		Not Used	
35		Not Used	
36	17999-19025	Arm, Pen Lift	
37	2190-0108	Washer, Lock, Split #4	
38	17999-19017	Light, Block Assy	
39	17999-18522	End Plate (LH)	
40	17999-19056	Clamp, Bulb Wire	
41	17999-19018	Clamp, Cable	

FIGURE 7-4. EXPLODED VIEW OF PEN CARRIAGE WITH ELECTRIC STYLUS AND PHOTO SLIDEWIRE

(Sheet 2 of 2)

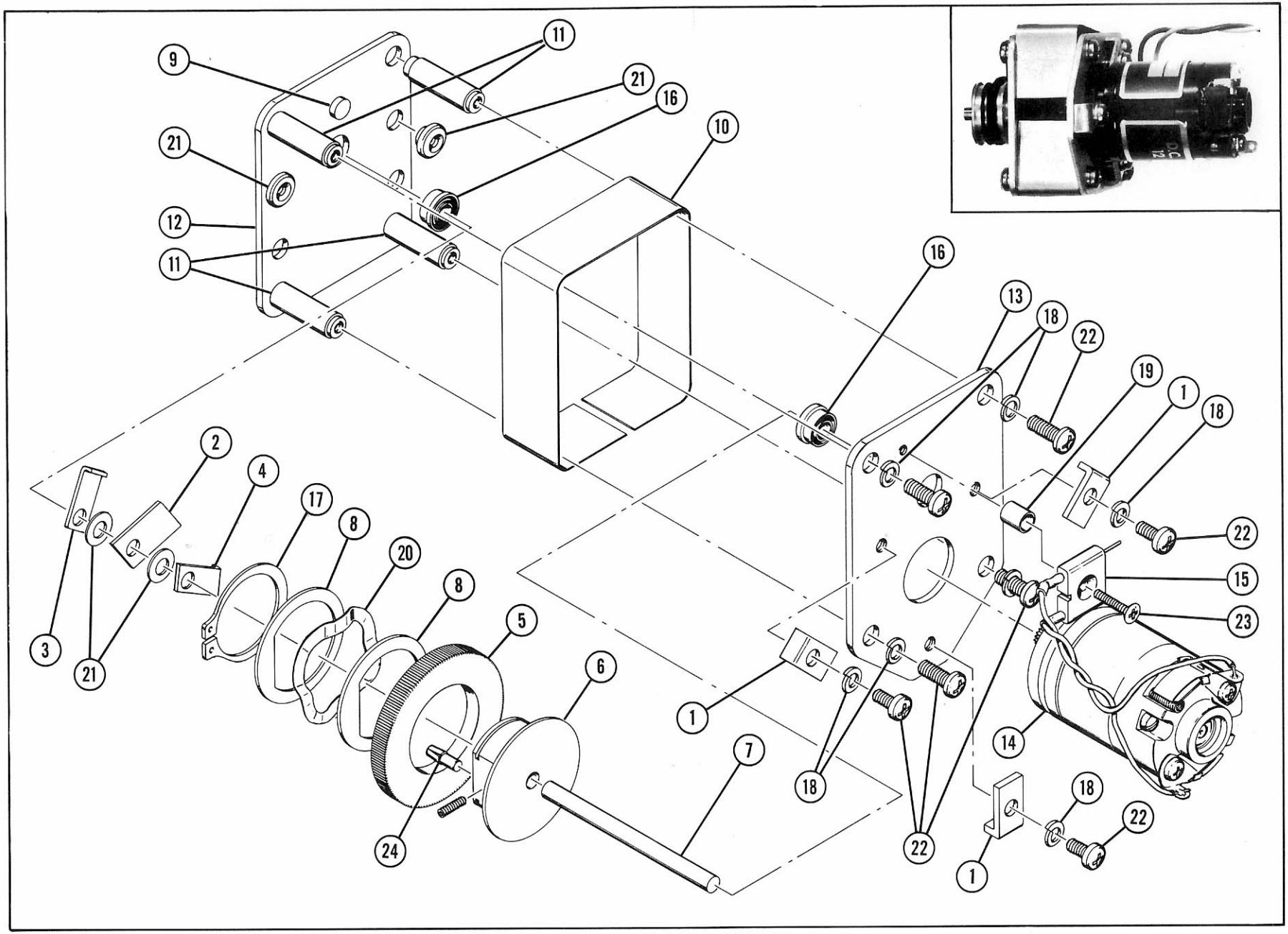
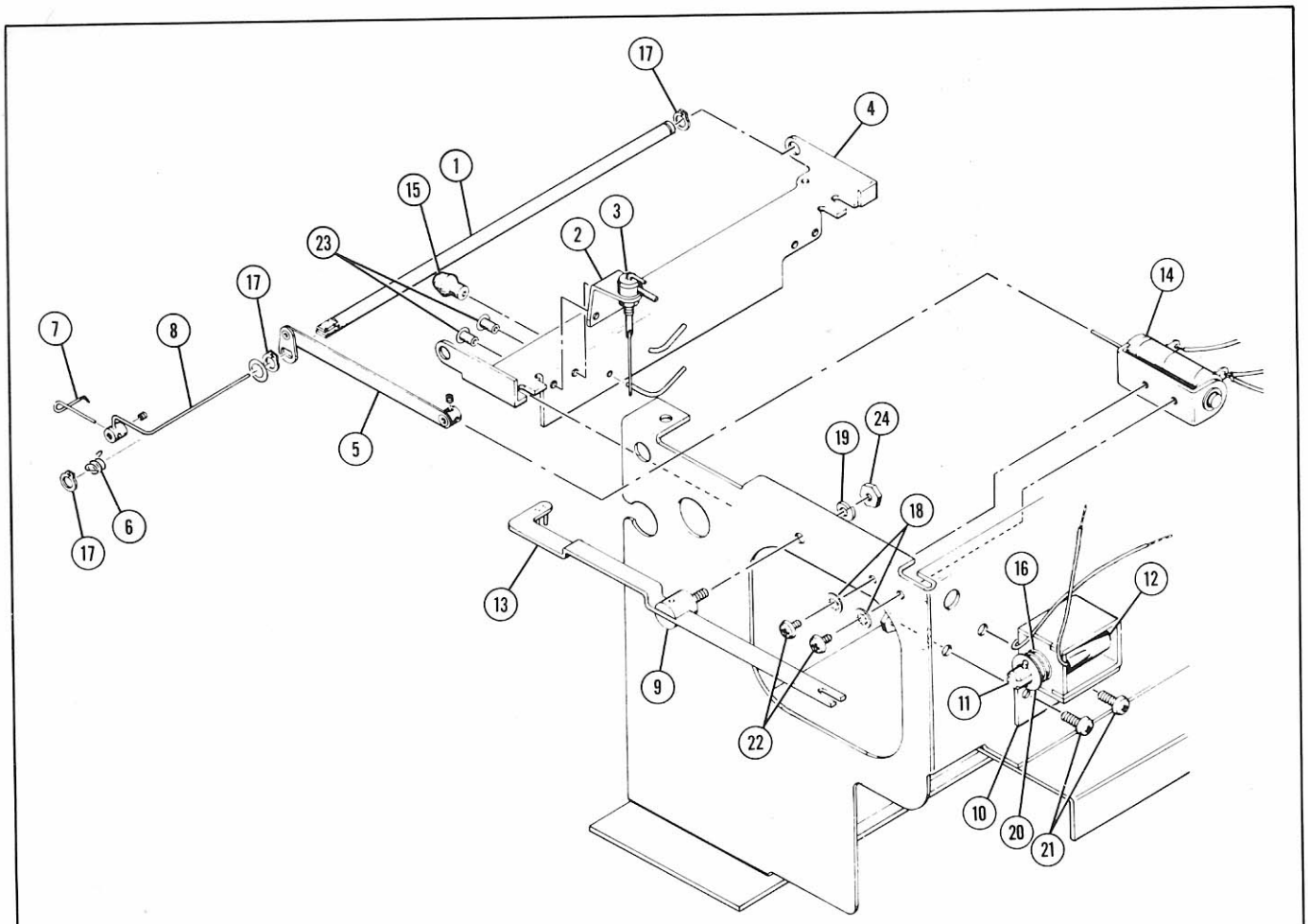


FIGURE 7-5. EXPLODED VIEW OF GEAR ASSEMBLY (P/N A10083) (Sheet 1 of 2)

LEGEND FOR FIGURE 7-5

Item	Part No.	Description	Mfr Designation
1	A-0033	Bracket	Hewlett-Packard
2	A-10202	Plate	Hewlett-Packard
3	A-10200-1	Finger	Hewlett-Packard
4	A-10200-2	Finger	Hewlett-Packard
5	A-10346	Gear	Hewlett-Packard
6	A-10347	Bushing	Hewlett-Packard
7	A-10348	Shaft	Hewlett-Packard
8	A-10351	Ring, Pressure	Hewlett-Packard
9	A-10365	Pin, Stop	Hewlett-Packard
10	A-10608	Cover	Hewlett-Packard
11	A-10609	Stand-off	Hewlett-Packard
12	A-10768	Plate, Mounting	Hewlett-Packard
13	A-10769	Plate, Mounting	Hewlett-Packard
14	A-10822	DC Motor	Hewlett-Packard
15	1251-1113	Connector	
16	1410-0273	Ball Bearing SFR 1445P1	
17	0510-0814	Ring, Retaining	
18	2190-0108	Washer, Split	
19	0380-0177	Spacer	
20	2190-0174	Washer, Spring WB24	
21	3050-0394	Washer, Flat, 0.02 Shim	
22	2270-0020	Screw	
23	0520-0106	Screw, Flathead	
24	0510-0854	Pin, Stop	

FIGURE 7-5. EXPLODED VIEW OF GEAR ASSEMBLY (P/N A10083) (Sheet 2 of 2)



Item	Part No.	Description	Mfr Designation
1	A11522	Rod	Hewlett-Packard
2	A10476	Bracket	Hewlett-Packard
3	A10534	Holder, Ink Cartridge	Hewlett-Packard
4	A10679	Bracket Assy	Hewlett-Packard
5	A10681	Arm	Hewlett-Packard
6	A11165	Springs, Return	Hewlett-Packard
7	B-18203	Pen Assembly	Hewlett-Packard
8	A12211	Pen Holder	Hewlett-Packard
9	A12212	Pivot	Hewlett-Packard
10	A12215	Bracket	Hewlett-Packard
11	A12250	Plunger, Solenoid	Hewlett-Packard
12	A12251	Coil, Solenoid	Hewlett-Packard
13	A12297	Actuator Arm Assy	Hewlett-Packard
14	A13046	Solenoid, Pen Lift	Hewlett-Packard
15	1530-0096	Bulb	
16	1460-0254	Spring, Solenoid	
17	0510-0238	Ring, Retaining	
18	2190-0108	Washer, Split	
19	2190-0105	Washer, Split	
20	3050-0386	Washer	
21	2460-0033	Screw	
22	2200-0056	Screw	
23	0361-0137	Rivet	
24	2420-0010	Nut	

FIGURE 7-6. EXPLODED VIEW OF INK EVENT MARKER ASSEMBLY

WAVEFORM NOTES

The waveforms on the schematics were taken with a Hewlett-Packard Model 130C oscilloscope, of a 680 series recorder of known quality. Test points may be made accessible by removing the top and bottom covers.

To obtain error signal:

a. Manually move pen one sub division (1/10", 2.54 mm).

b. Note error signal on scope.

c. Using zero control suppress zero (set zero beyond graph limits) for same amplitude signal. This allows a constant error signal without manually holding pen off null.

GENERAL SETTINGS UNLESS OTHERWISE STATED

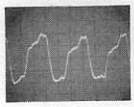
OSCILLOSCOPE SETTINGS

1. 5 ms/cm sweep speed.
2. Attenuator probe NOT used.
3. Observe scope polarity, negative side is connected to chassis ground.

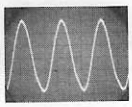
RECORDER SETTINGS

1. Recorder must be grounded.
2. Short input terminals.
3. Recorder must be in normal operating position, i.e., flat on table or horizontal in rack. Do not set on side as the weight of the carriage beam will cause an error signal.
4. Set the gain to 70% (mechanical) of its adjustable range.

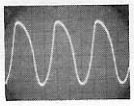
TP2



NULL
0.5 MV/CM

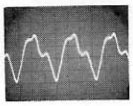


1%
5 MV/CM

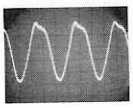


10%
50 MV/CM

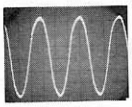
TP1



NULL
0.5 MV/CM

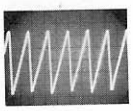


1%
1 MV/CM

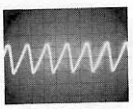


10%
5 MV/CM

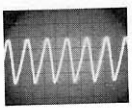
TP



-33V SUPP
EVENT MKR AND
PEN ON
5 V/CM

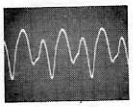


-33V SUPP
PEN DOWN
5 V/CM



-33V SUPP
NO LOAD
5 V/CM

TP



12V SUPP
5 MV/CM

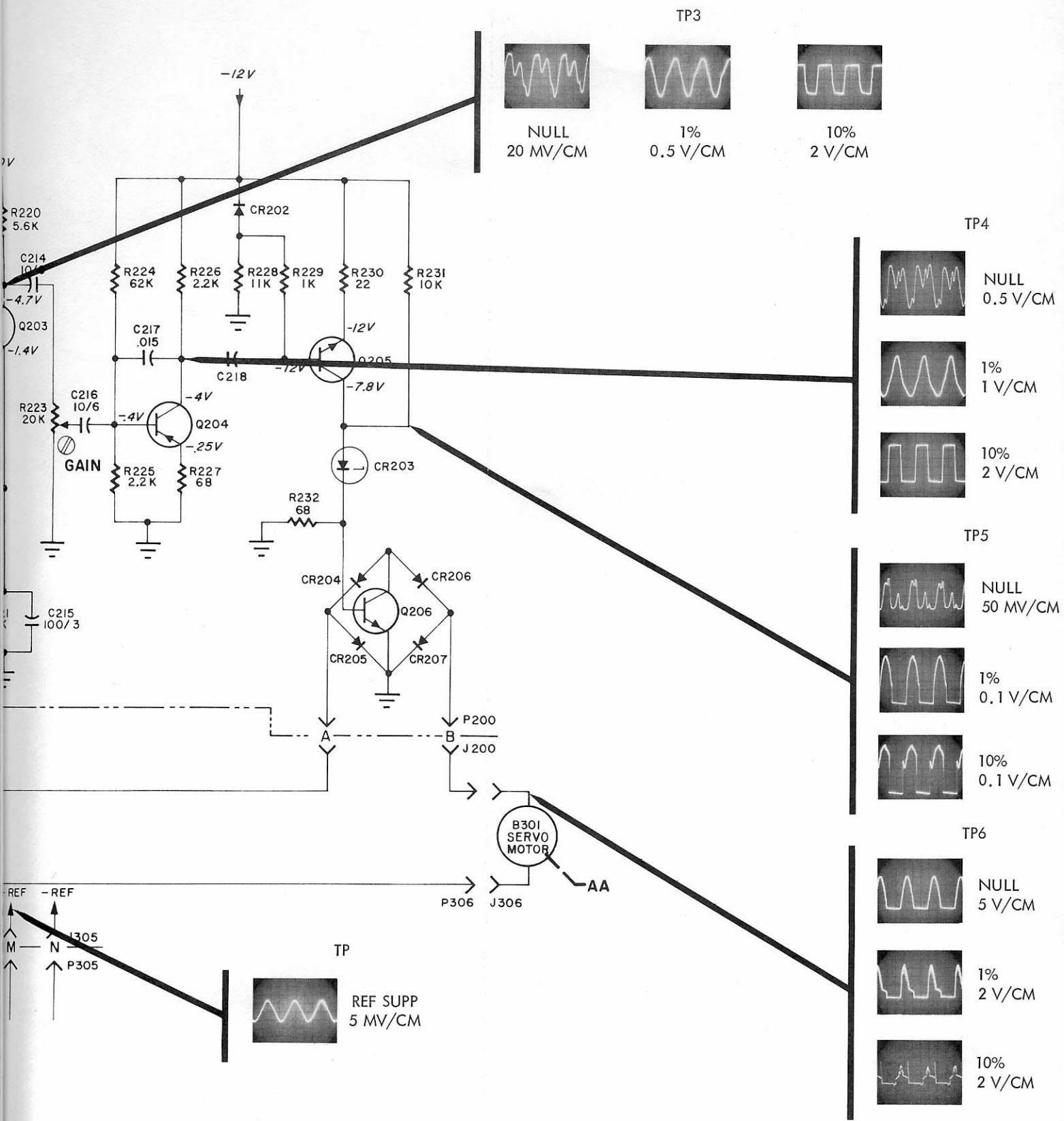


FIGURE 7-7. WAVEFORI

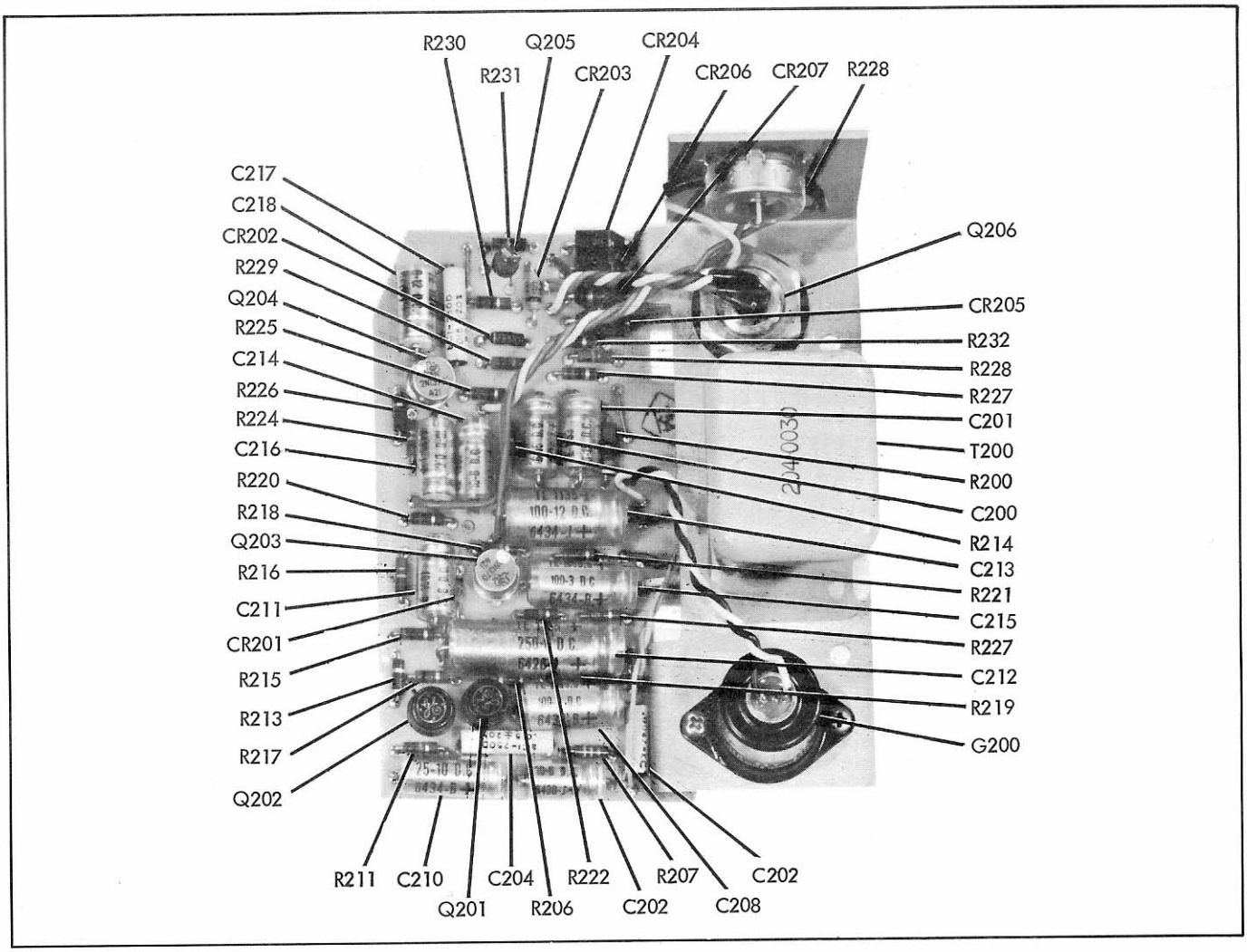


FIGURE 7-8. SERVO AMPLIFIER

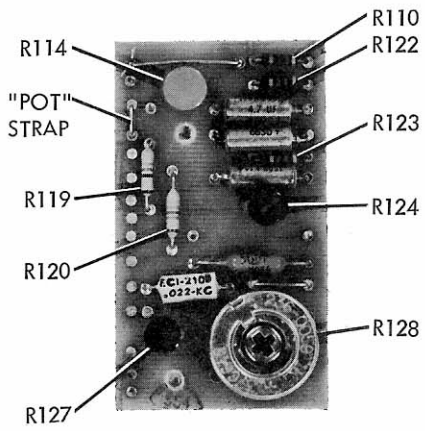


FIGURE 7-9. INPUT CIRCUIT BOARD

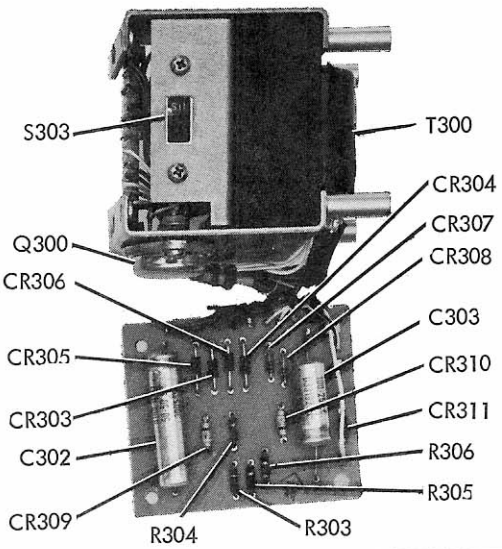


FIGURE 7-10. POWER SUPPLY

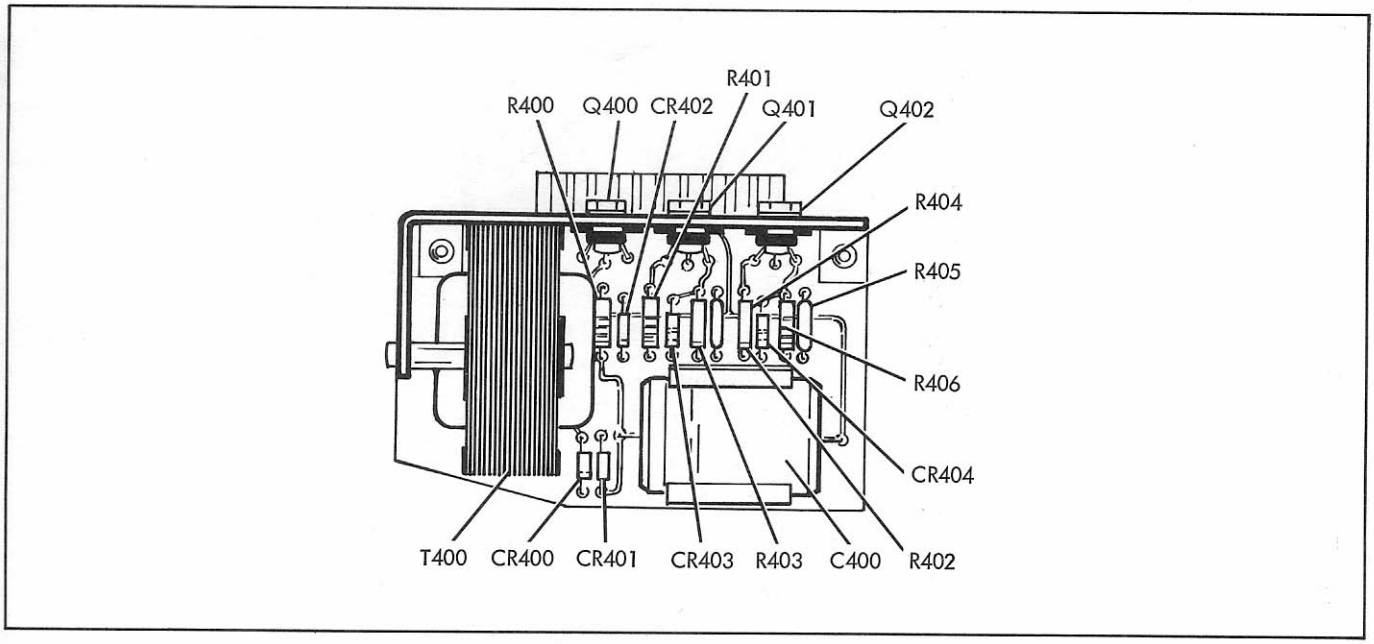


FIGURE 7-11. ELECTRIC WRITING POWER SUPPLY (P/N 5080-7794)

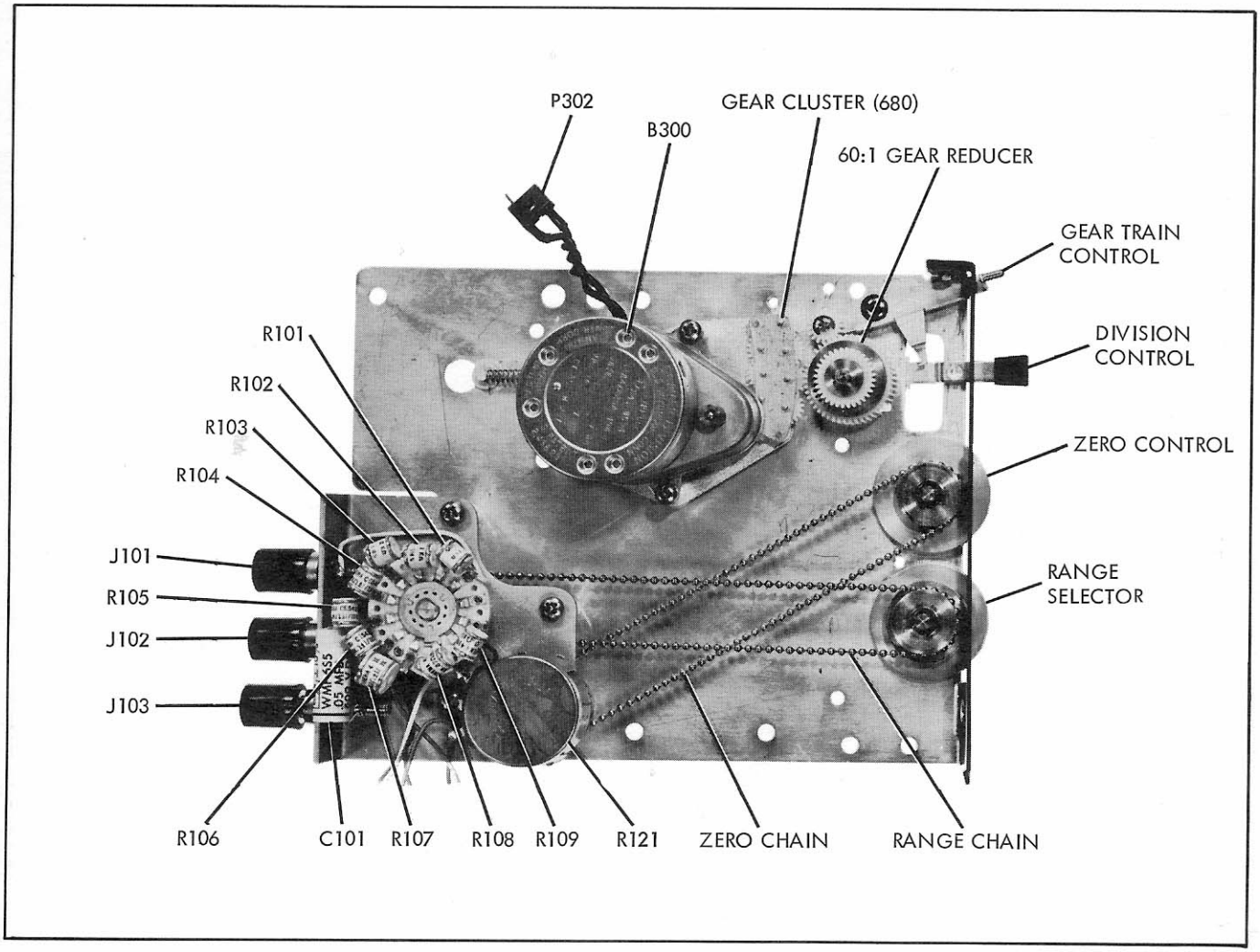
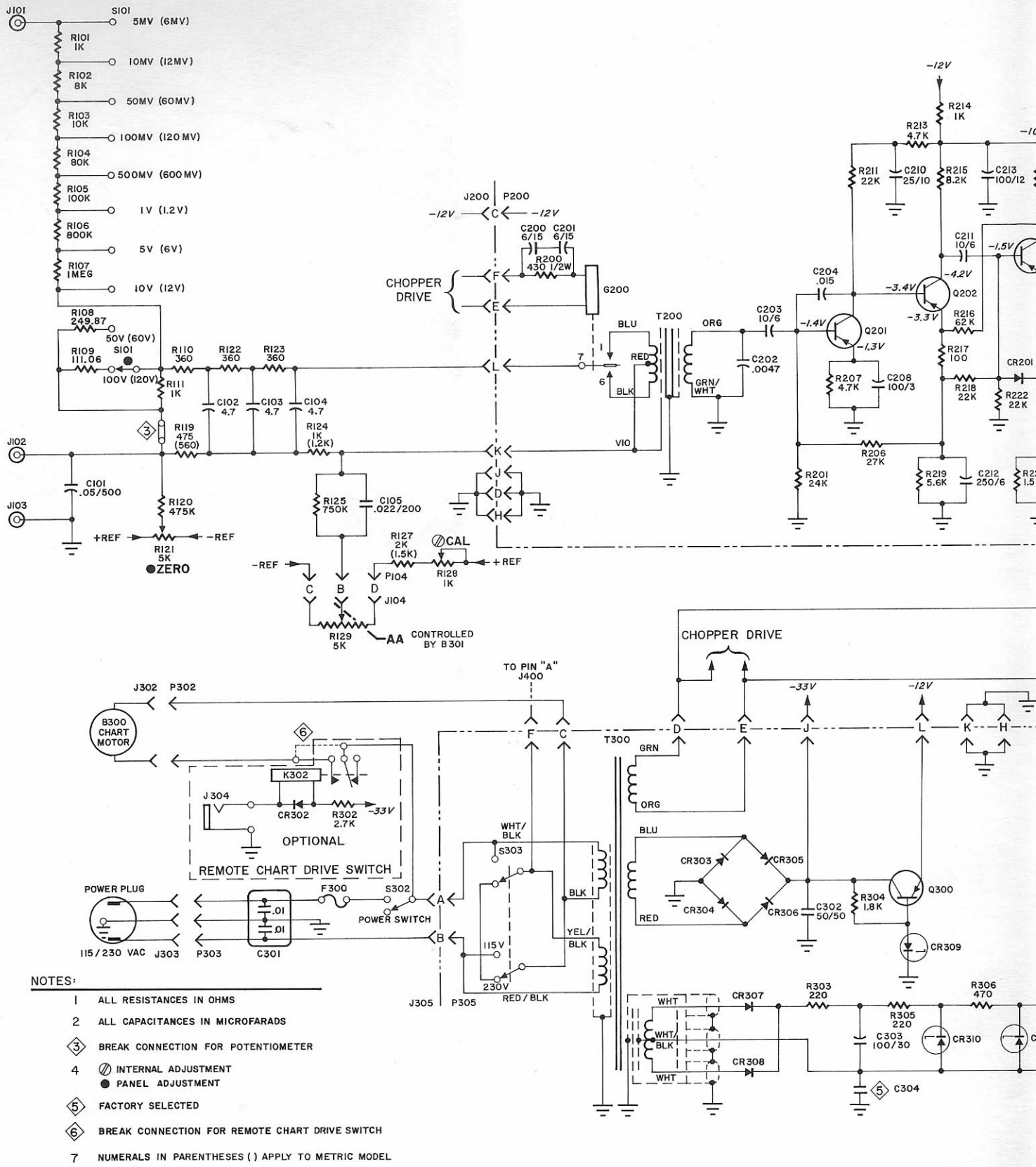


FIGURE 7-12. CHART DRIVE AND INPUT ASSEMBLY



NOTES:

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. BREAK CONNECTION FOR POTENTIOMETER
4. INTERNAL ADJUSTMENT
   PANEL ADJUSTMENT
5. FACTORY SELECTED
6. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
7. NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODEL

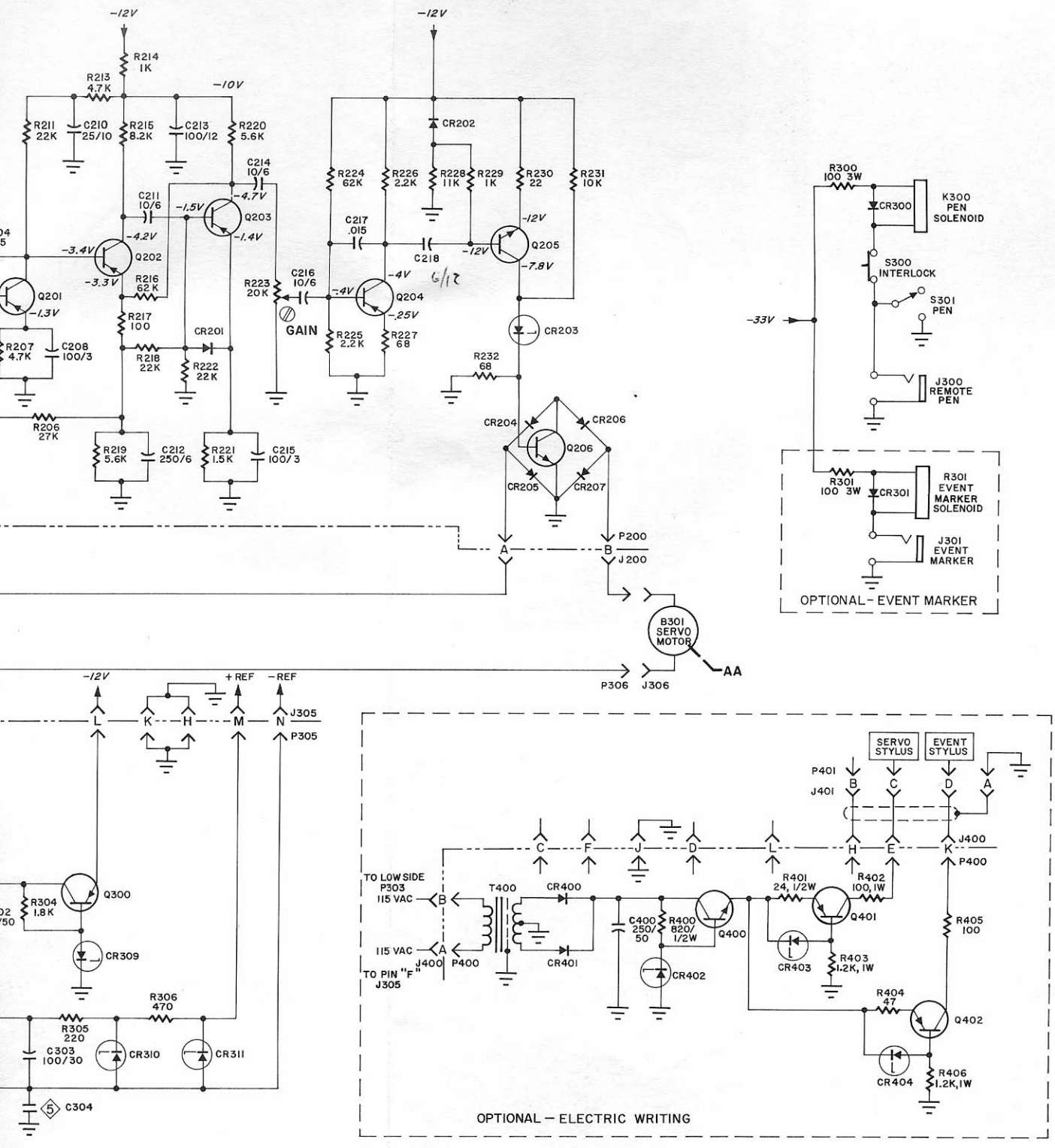


FIGURE 7-13. 680/68M SCHEMATIC D5950-7314

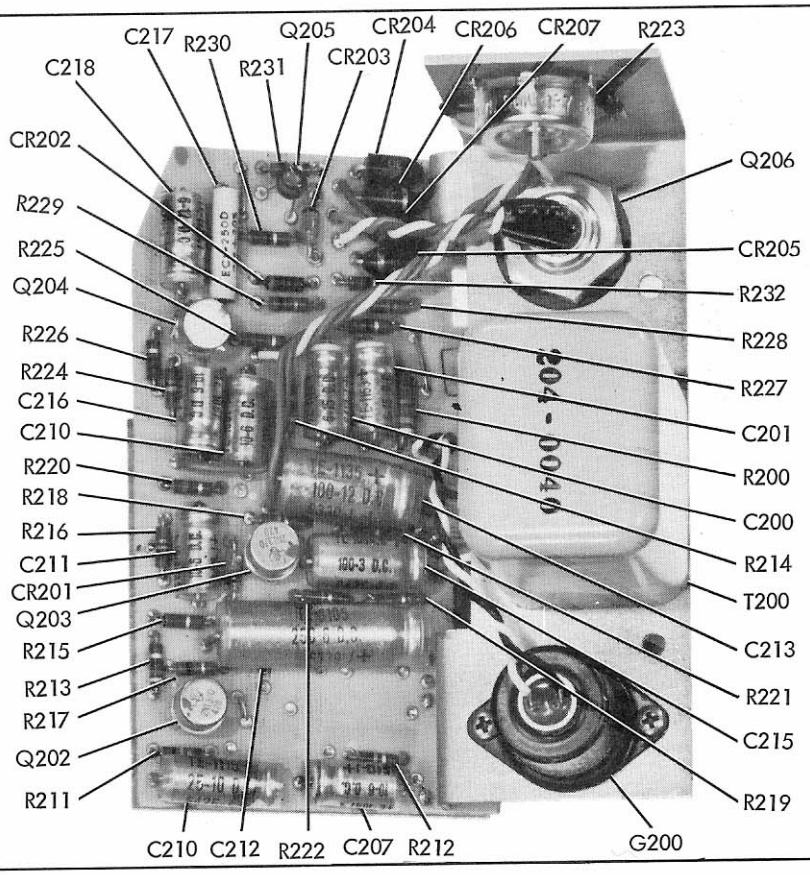


FIGURE 7-14. 100K INPUT SERVO AMPLIFIER

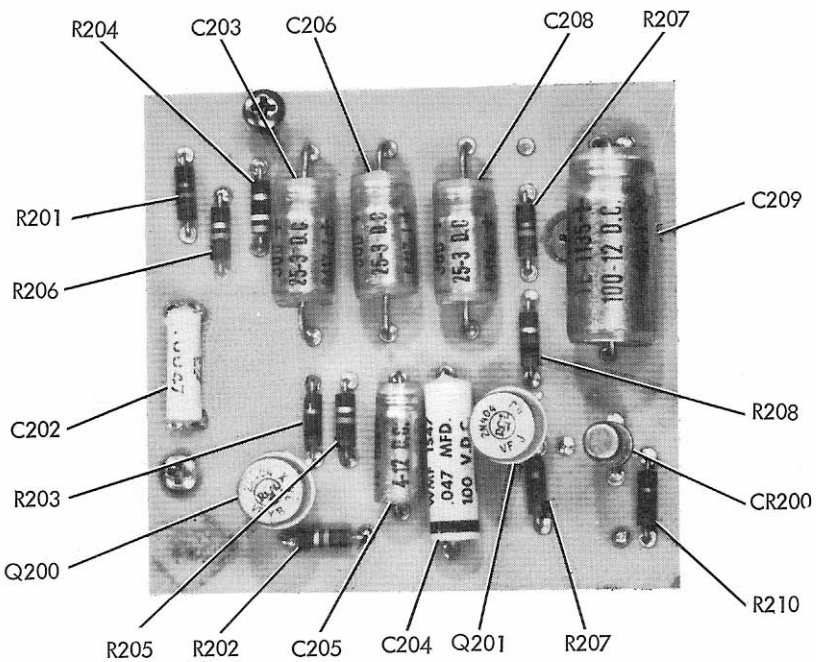


FIGURE 7-15. MODEL 680 (100K) PREAMPLIFIER

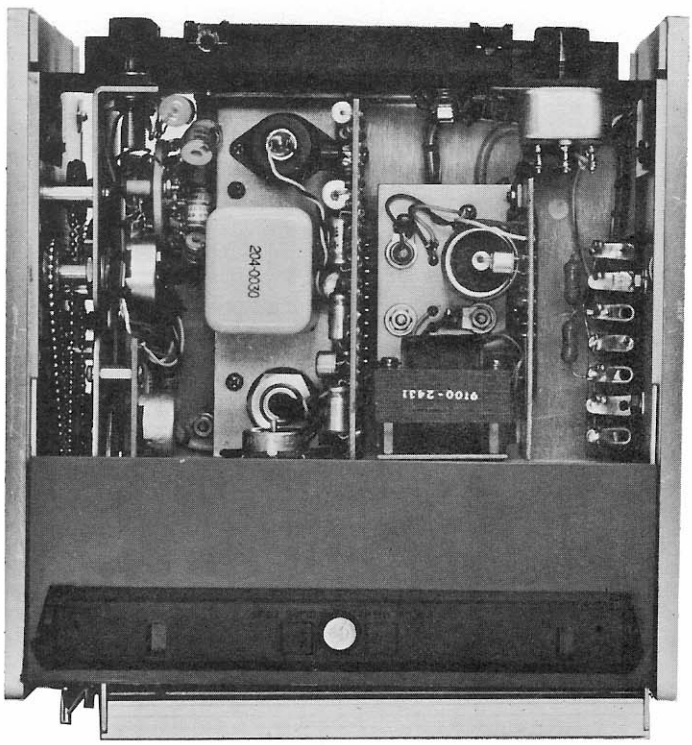
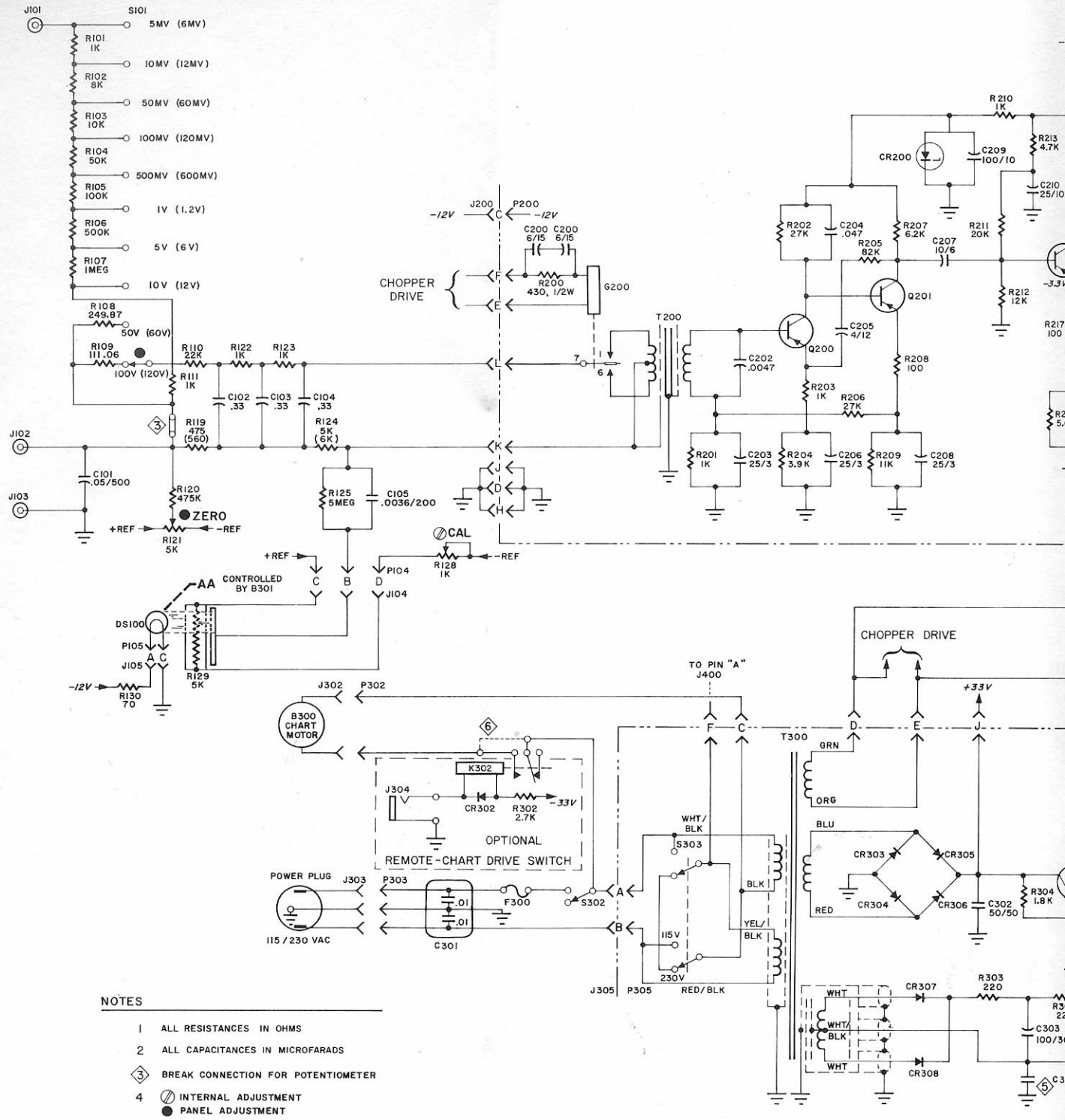


FIGURE 7-16. 680 BOTTOM VIEW



NOTES

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. BREAK CONNECTION FOR POTENTIOMETER
4. INTERNAL ADJUSTMENT; PANEL ADJUSTMENT
5. FACTORY SELECTED
6. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
7. NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODELS

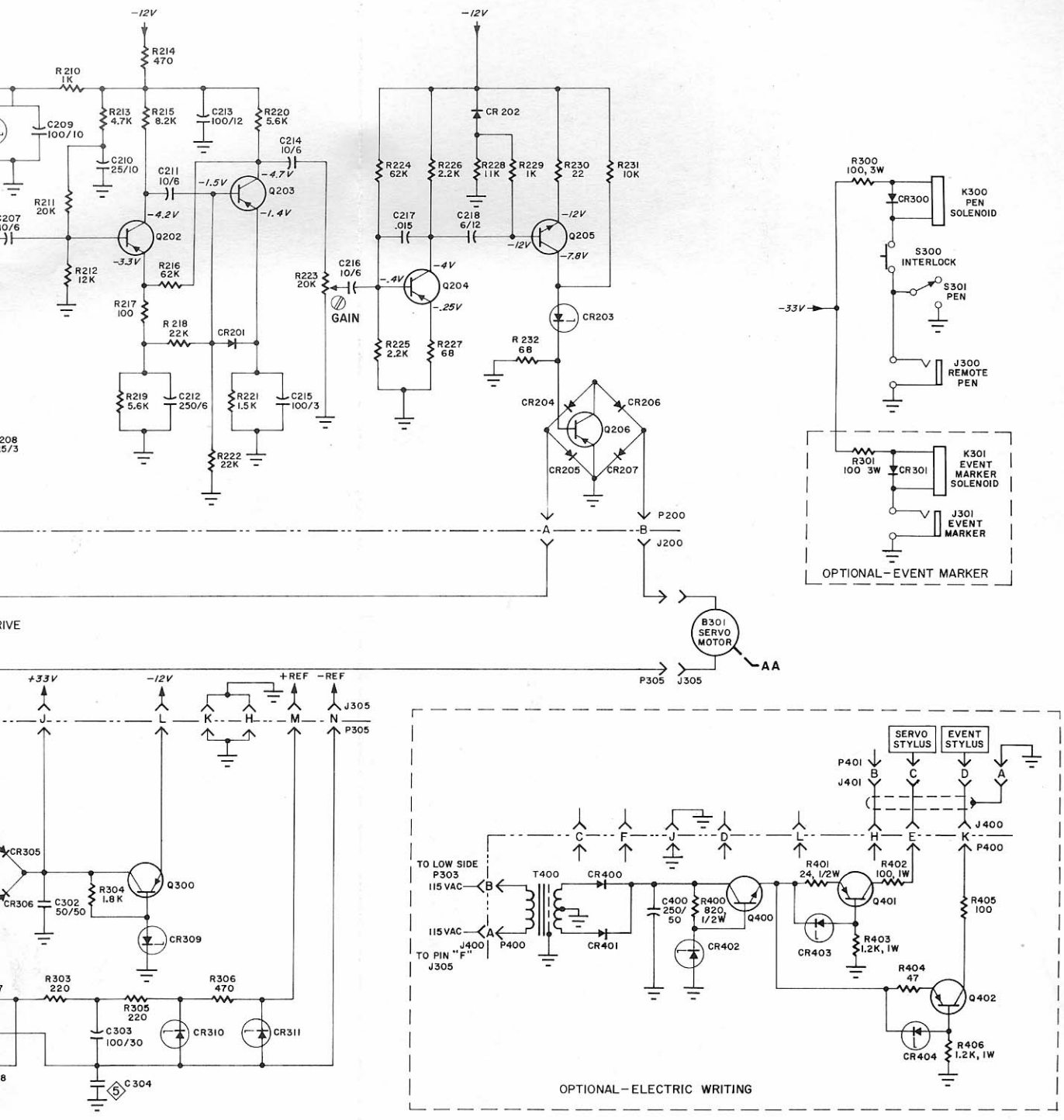
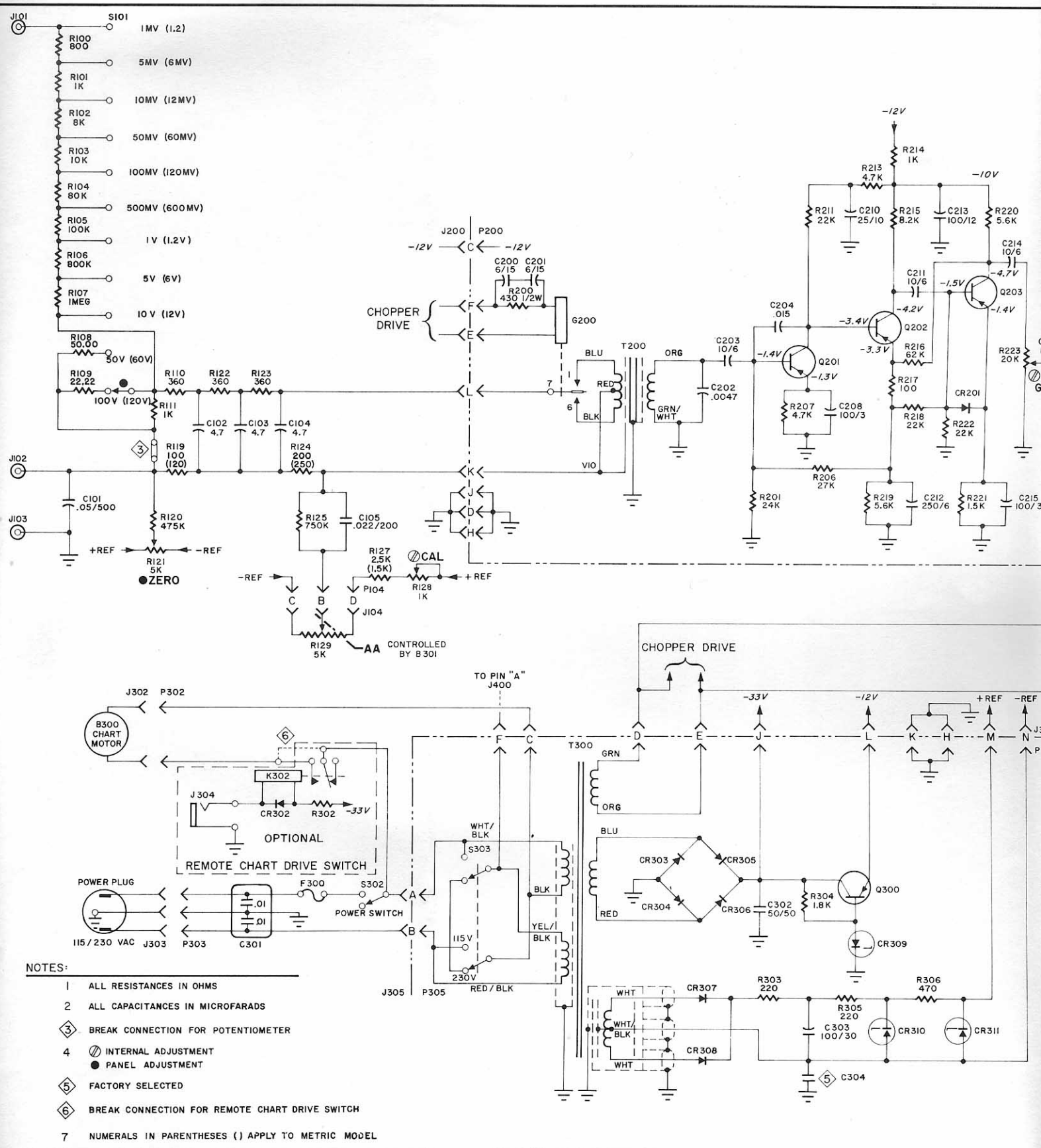


FIGURE 7-17. 680-17/680M-17
SCHEMATIC D5950-7320



NOTES:

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. BREAK CONNECTION FOR POTENTIOMETER
4. ⊘ INTERNAL ADJUSTMENT
   ● PANEL ADJUSTMENT
5. FACTORY SELECTED
6. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
7. NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODEL

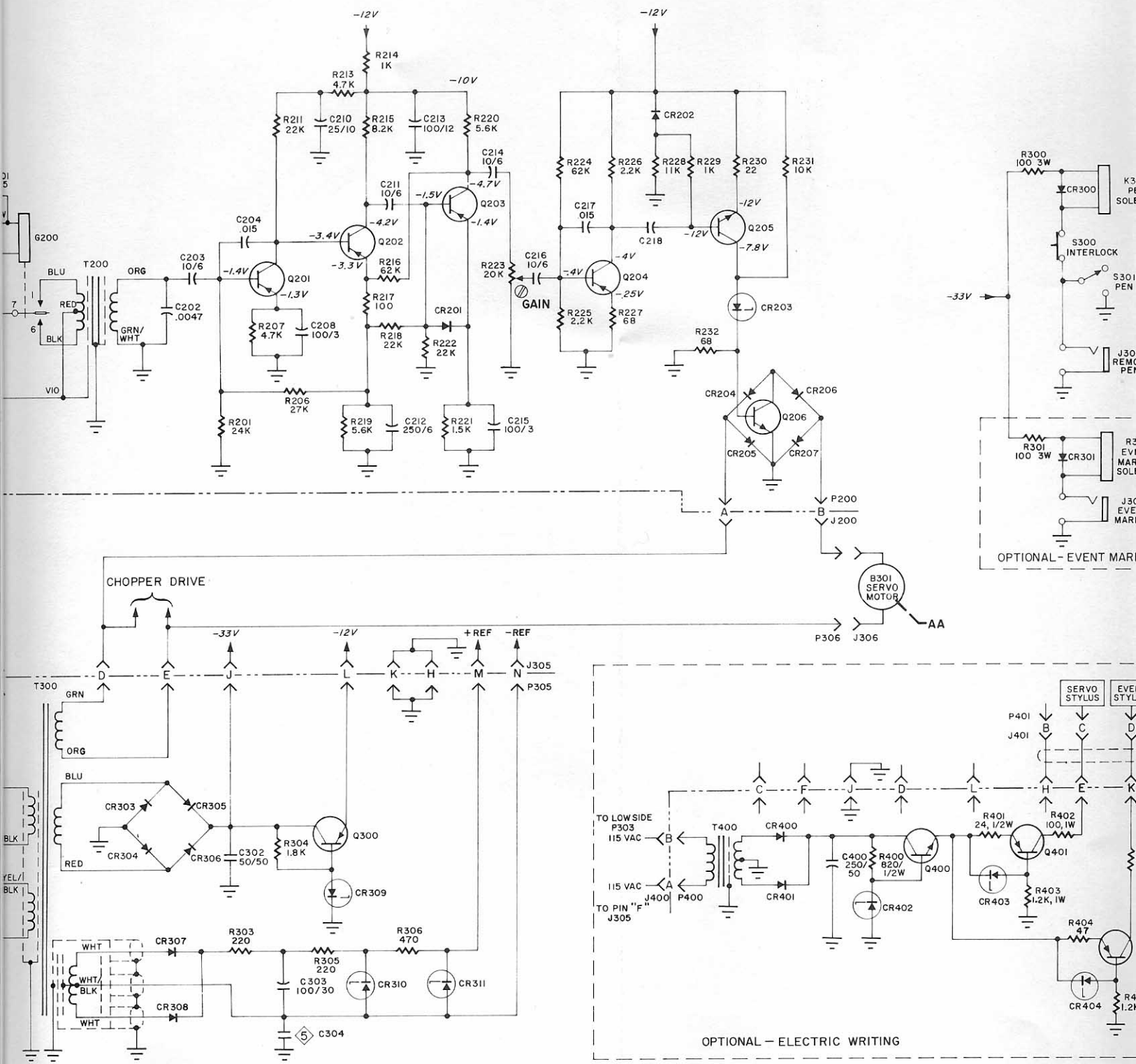


FIGURE 7-18. HC
SCHEMATIC

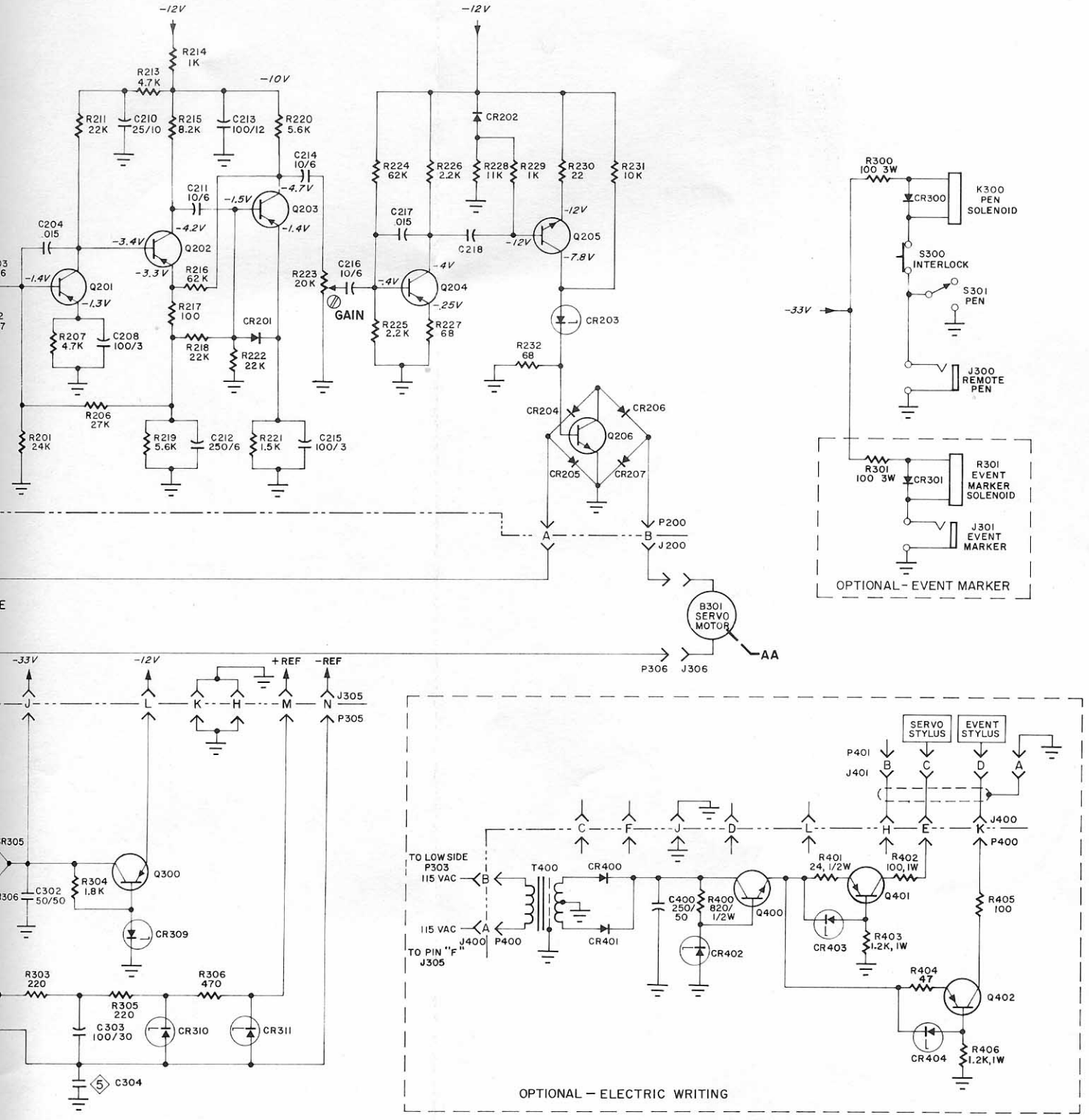
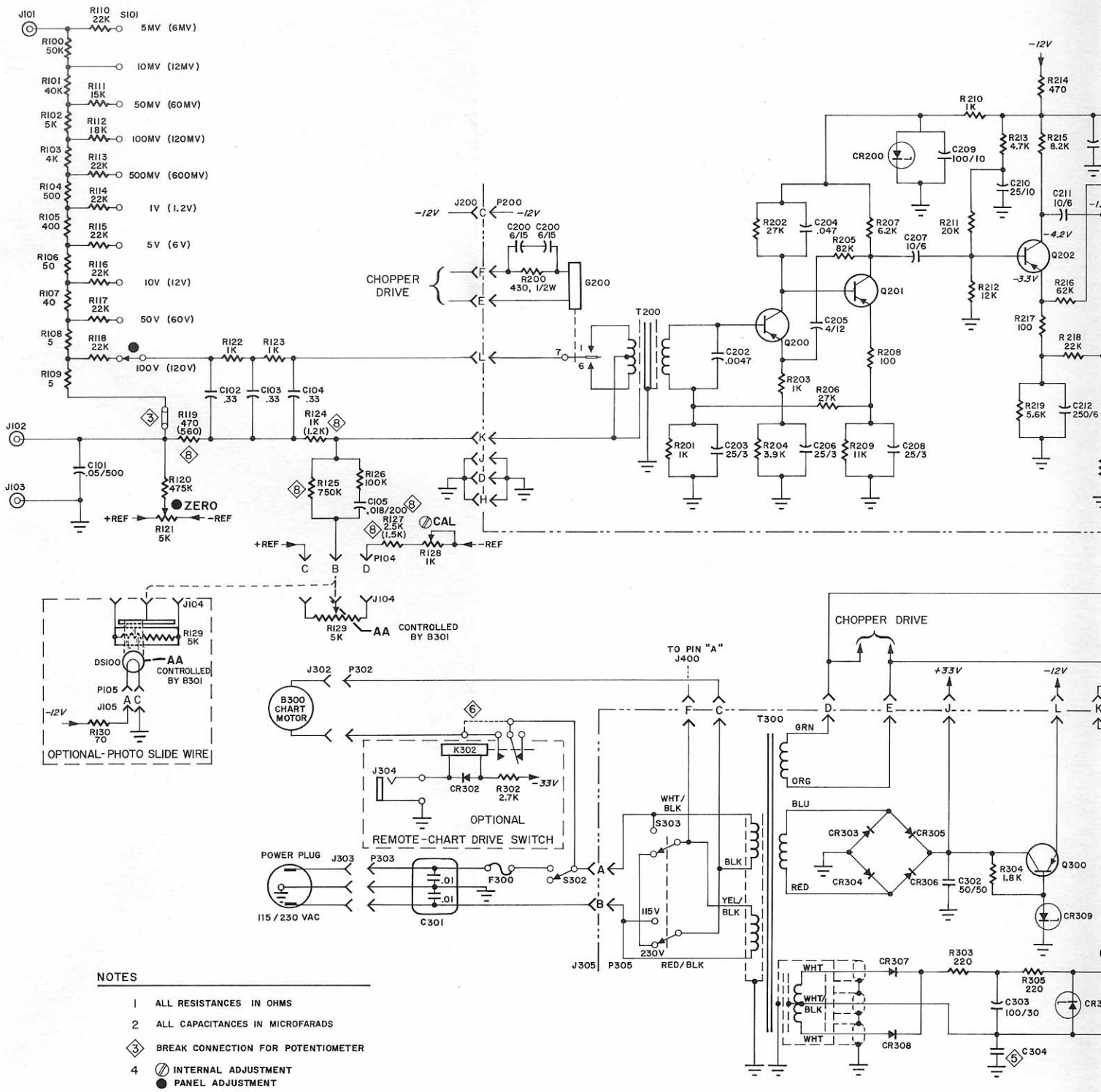


FIGURE 7-18. H01-680/H01-680M
SCHEMATIC D5950-7316



NOTES

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. BREAK CONNECTION FOR POTENTIOMETER
4. ⊘ INTERNAL ADJUSTMENT
   ● PANEL ADJUSTMENT
5. FACTORY SELECTED
6. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
7. NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODEL
8. VALUE CHANGES WITH OPTIONS REFER TO PARTS LIST

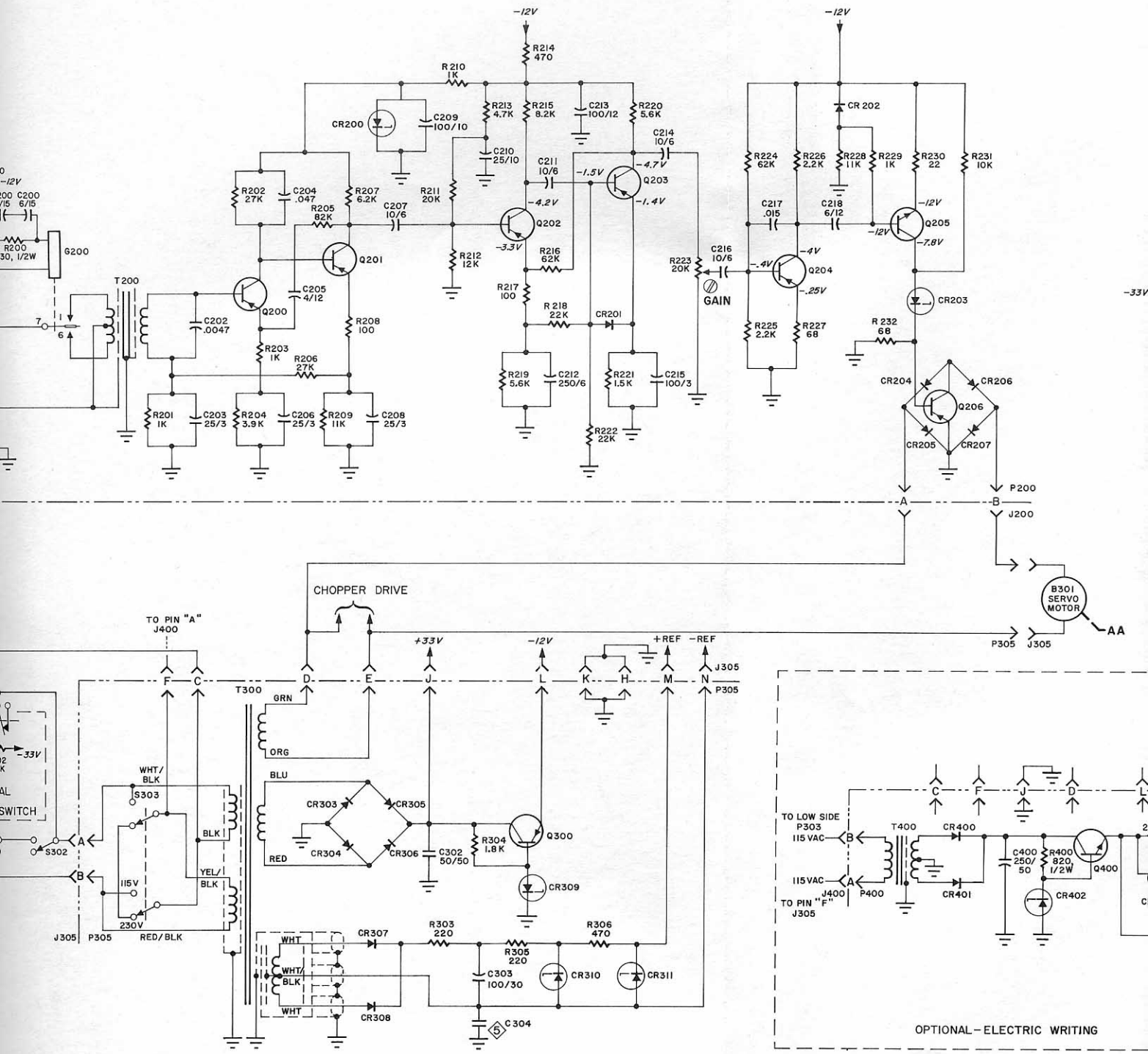

-12V
R214 470
R210 1K
CR200
C209 100/10
R213 4.7K
R215 8.2K
C213 100/12
R220 5.6K
C214 10/6
C210 25/10
C211 10/6
-1.5V
-4.7V
Q203
-1.4V
-4.2V
Q202
-3.3V
R211 20K
R212 12K
R216 62K
R217 100
R218 22K
CR201
R219 5.6K
C212 250/6
R221 1.5K
C215 100/3
R222 22K
R223 20K
C216 10/6
GAIN
R202 27K
C204 .047
R207 6.2K
R205 82K
C207 10/6
Q201
C205 4/12
Q200
C202 .0047
R208 100
R203 1K
R206 27K
R201 1K
C203 25/3
R204 3.9K
C206 25/3
R209 11K
C208 25/3
T200
G200
R200 30, 1/2W
C200 /15 6/15
CR 202
R224 62K
R226 2.2K
R228 11K
R229 1K
R230 22
R231 10K
C217 .015
C218 6/12
-12V
Q205
-7.8V
-4V
-.4V
Q204
-.25V
R225 2.2K
R227 68
R 232 68
CR203
CR204
CR206
Q206
CR205
CR207
P200
J200
A
B
CHOPPER DRIVE
B301 SERVO MOTOR
AA
P305
J305
TO PIN "A" J400
+33V
-12V
+REF
-REF
F
C
D
E
J
L
K
H
M
N
T300
GRN
ORG
WHT/ BLK
S303
BLK
YEL/ BLK
115V
230V
S302
RED/BLK
BLU
RED
CR303
CR305
CR304
CR306
C302 50/50
R304 1.8K
Q300
CR309
CR307
R303 220
R305 220
R306 470
C303 100/30
CR310
CR311
WHT
WHT/ BLK
CR308
C304
5
TO LOW SIDE P303
115 VAC
T400
CR400
C400 250/ 50
R400 820 1/2W
Q400
CR402
CR401
P400
TO PIN "F" J305
OPTIONAL-ELECTRIC WRITING

FIGURE 7-19. H

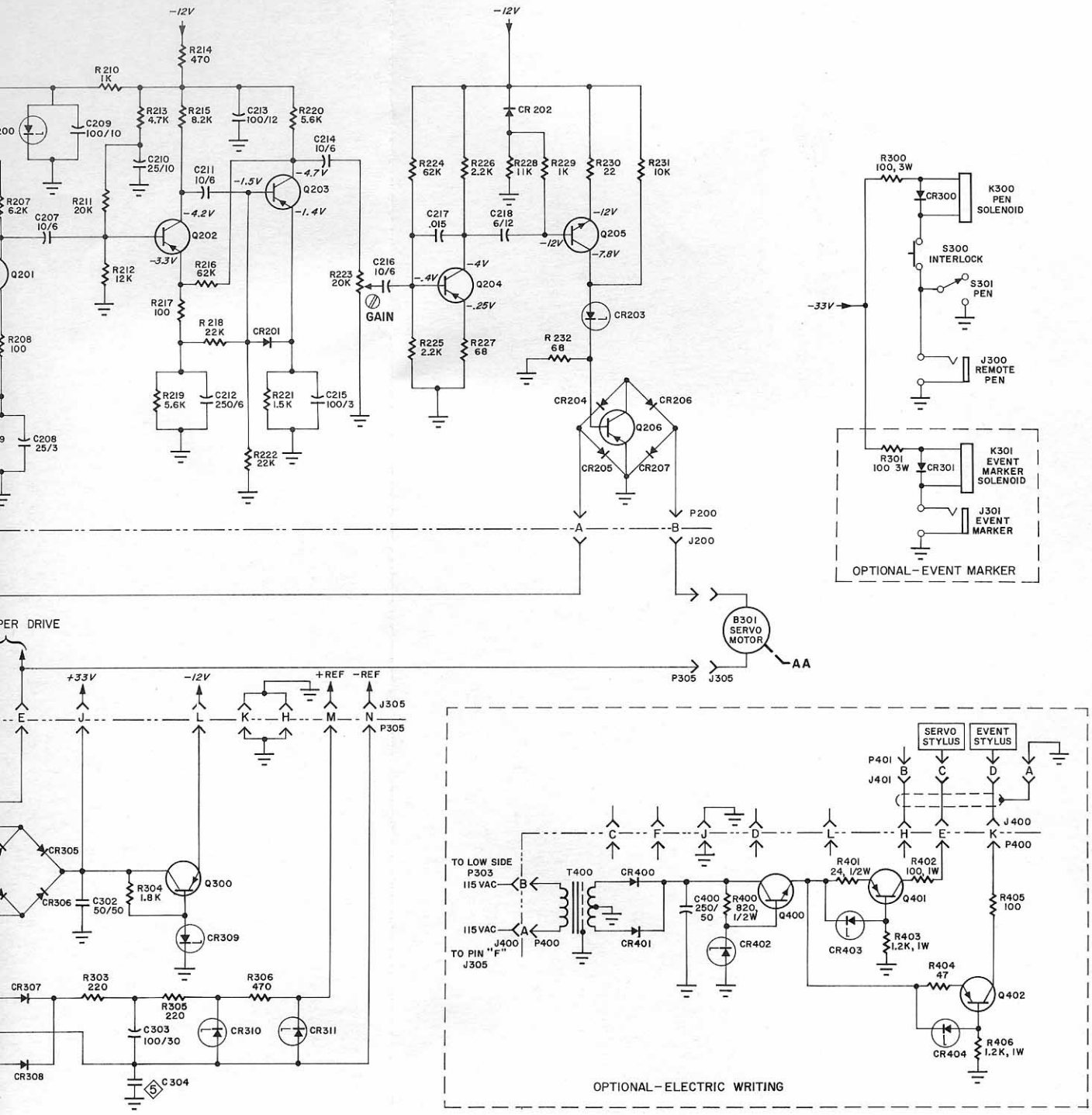
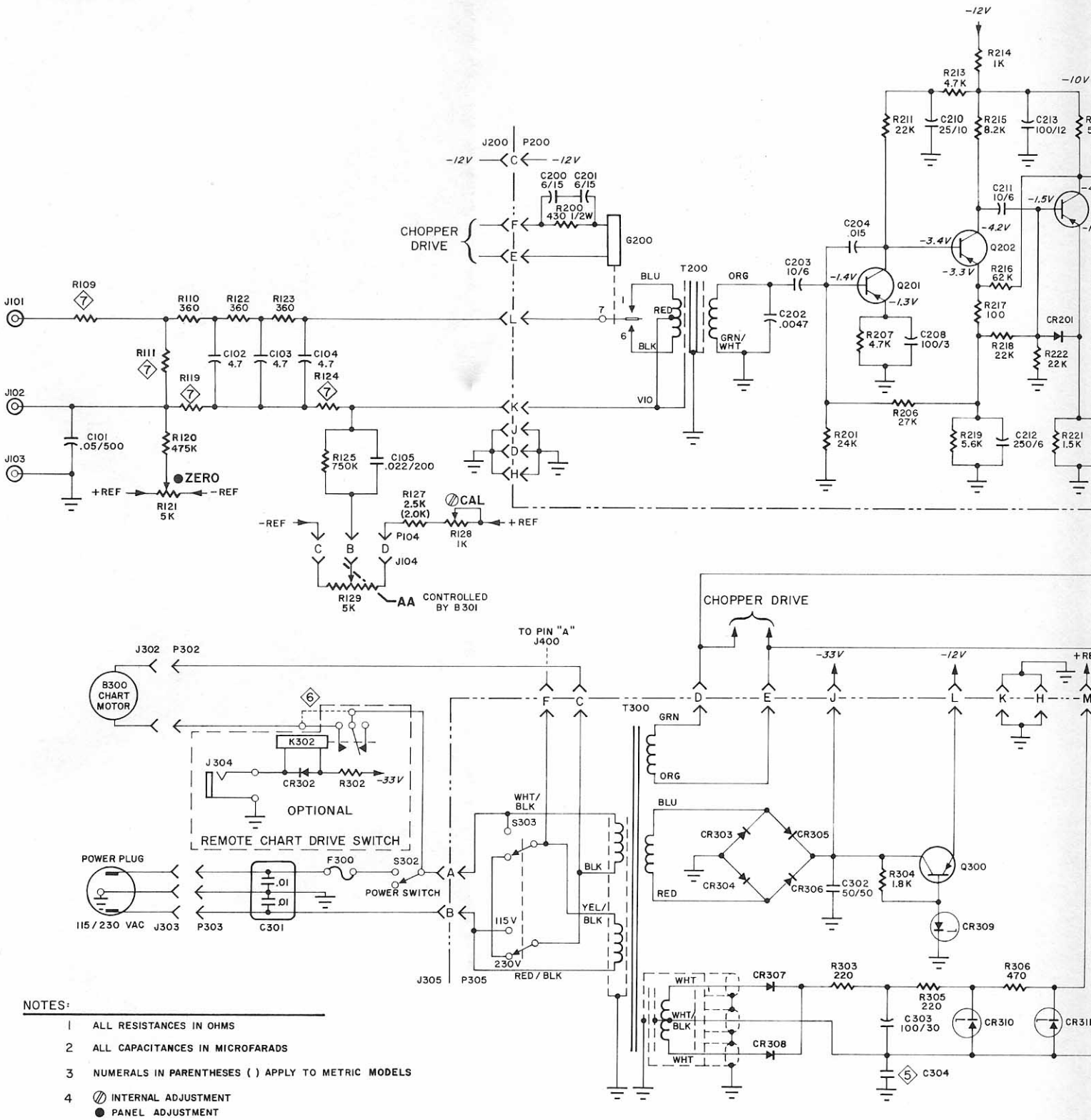


FIGURE 7-19. H02-680/H02-680M SCHEMATIC
D5950-7315



NOTES:

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODELS
4. ⊘ INTERNAL ADJUSTMENT
   ● PANEL ADJUSTMENT
5. FACTORY SELECTED
6. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH OPTION
7. FOR VALUES REFER TO FIGURE 6-3

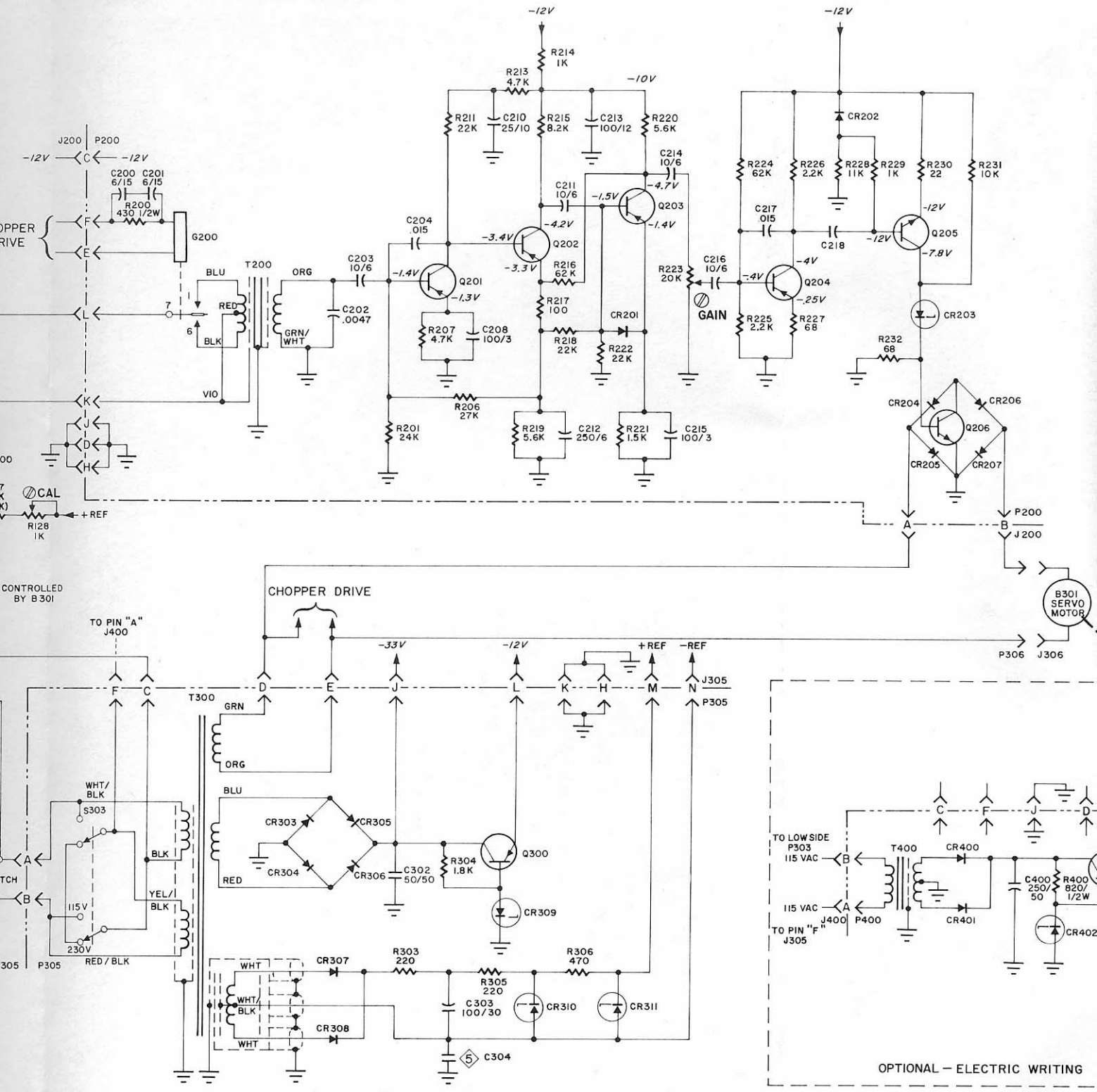

-12V
R214 1K
R213 4.7K
-10V
R211 22K
C210 25/10
R215 8.2K
C213 100/12
R220 5.6K
C214 10/6
-4.7V
C211 10/6
-1.5V
Q203
-1.4V
-4.2V
-3.4V
Q202
-3.3V
R216 62K
C204 .015
C203 10/6
-1.4V
Q201
-1.3V
R217 100
CR201
R207 4.7K
C208 100/3
R218 22K
R222 22K
R206 27K
R201 24K
R219 5.6K
C212 250/6
R221 1.5K
C215 100/3
R223 20K
C216 10/6
GAIN
R224 62K
R226 2.2K
R228 11K
R229 1K
R230 22
R231 10K
CR202
C217 015
C218
-12V
Q205
-7.8V
-4V
Q204
-.25V
R225 2.2K
R227 68
CR203
R232 68
CR204
CR206
Q206
CR205
CR207
J200 P200
-12V
C200 6/15
C201 6/15
R200 430 1/2W
G200
BLU
T200
ORG
C202 .0047
GRN/ WHT
RED
BLK
VIO
CAL
R128 1K
+REF
P200
J200
A
B
B301 SERVO MOTOR
P306
J306
CONTROLLED BY B301
CHOPPER DRIVE
TO PIN "A" J400
-33V
-12V
+REF
-REF
J305
P305
T300
GRN
ORG
WHT/ BLK
S303
BLK
YEL/ BLK
115V
230V
RED / BLK
BLU
CR303
CR305
CR304
CR306
C302 50/50
R304 1.8K
Q300
CR309
WHT
CR307
R303 220
R306 470
R305 220
C303 100/30
CR310
CR311
CR308
C304
TO LOW SIDE P303 115 VAC
115 VAC
TO PIN "F" J305
T400
CR400
CR401
J400
P400
C400 250/ 50
R400 820/ 1/2W
CR402
OPTIONAL – ELECTRIC WRITING

FIGURE 7

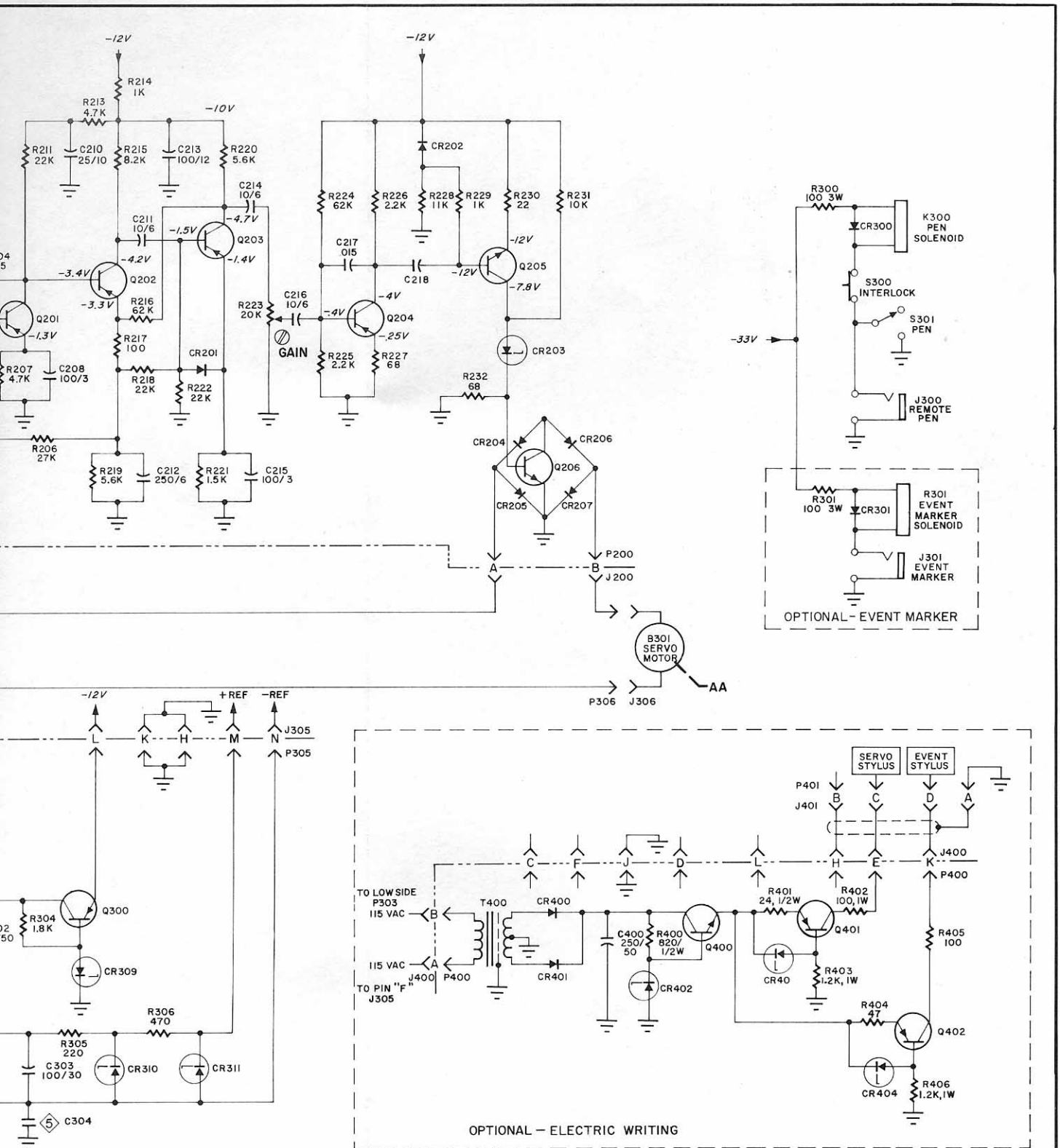
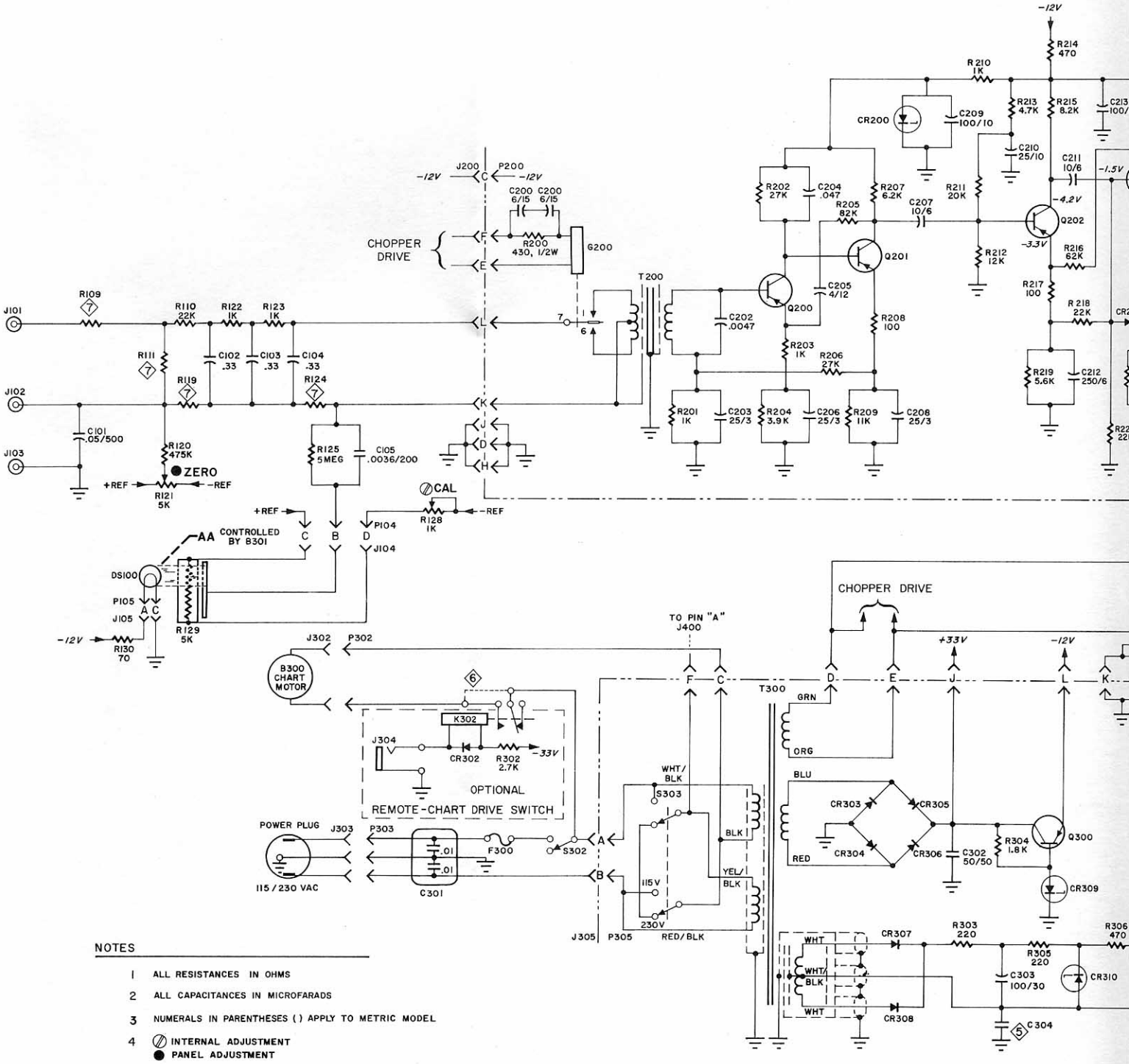


FIGURE 7-20. 681/681M SCHEMATIC D5950-7317



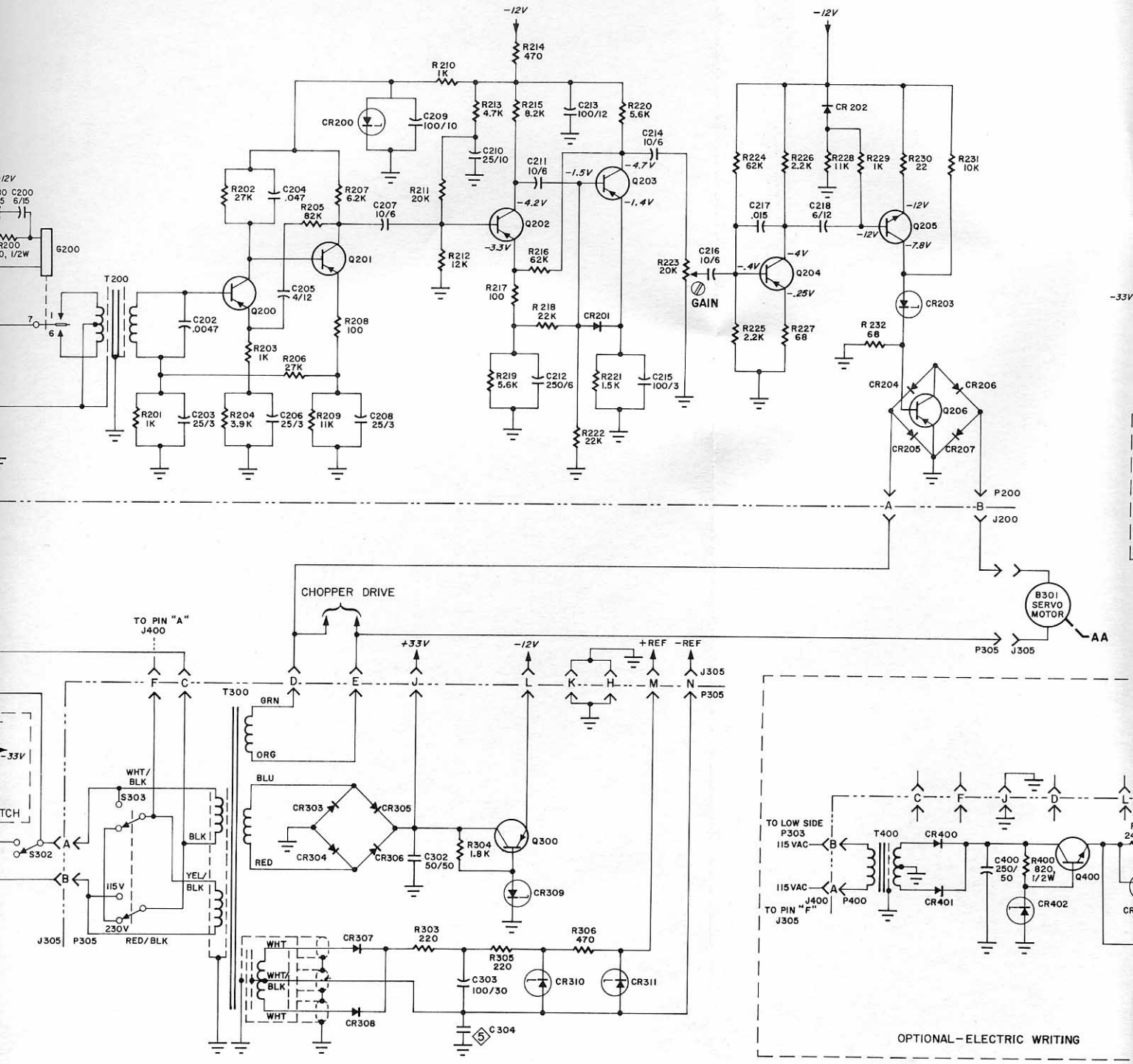
NOTES

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. NUMERALS IN PARENTHESES ( ) APPLY TO METRIC MODEL
4. ⊘ INTERNAL ADJUSTMENT
   ● PANEL ADJUSTMENT

⑤ FACTORY SELECTED

⑥ BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH

⑦ FOR VALUES REFER TO SEPARATE PARTS LIST


-12V
R214 470
R210 1K
CR200
C209 100/10
R213 4.7K
R215 8.2K
C213 100/12
R220 5.6K
C214 10/6
C210 25/10
C211 10/6
-4.7V
Q203
-1.5V
-1.4V
-4.2V
Q202
-3.3V
R202 27K
C204 .047
R207 6.2K
R205 82K
C207 10/6
R211 20K
R212 12K
R216 62K
Q201
T200
Q200
C205 4/12
C202 .0047
R208 100
R203 1K
R206 27K
R217 100
R218 22K
CR201
R219 5.6K
C212 250/6
R221 1.5K
C215 100/3
R222 22K
R201 1K
C203 25/3
R204 3.9K
C206 25/3
R209 11K
C208 25/3
G200
7
6
CR 202
R224 62K
R226 2.2K
R228 11K
R229 1K
R230 22
R231 10K
C217 .015
C218 6/12
-12V
Q205
-7.8V
-4V
-.4V
Q204
-.25V
R223 20K
C216 10/6
GAIN
R225 2.2K
R227 68
CR203
R 232 68
CR204
CR206
Q206
CR205
CR207
P200
A
B
J200
CHOPPER DRIVE
B301 SERVO MOTOR
AA
P305
J305
TO PIN "A" J400
+33V
-12V
+REF
-REF
F
C
D
E
J
L
K
H
M
N
T300
GRN
ORG
BLU
RED
WHT/ BLK
S303
S302
BLK
YEL/ BLK
115V
230V
RED/BLK
CR303
CR305
CR304
CR306
C302 50/50
R304 1.8K
Q300
CR309
WHT
WHT/ BLK
CR307
R303 220
R305 220
R306 470
C303 100/30
CR310
CR311
CR308
C304
TO LOW SIDE P303
115 VAC
115 VAC
J400
P400
TO PIN "F" J305
T400
CR400
CR401
C400 250/ 50
R400 820, 1/2W
Q400
CR402
OPTIONAL – ELECTRIC WRITING

FIGU
S

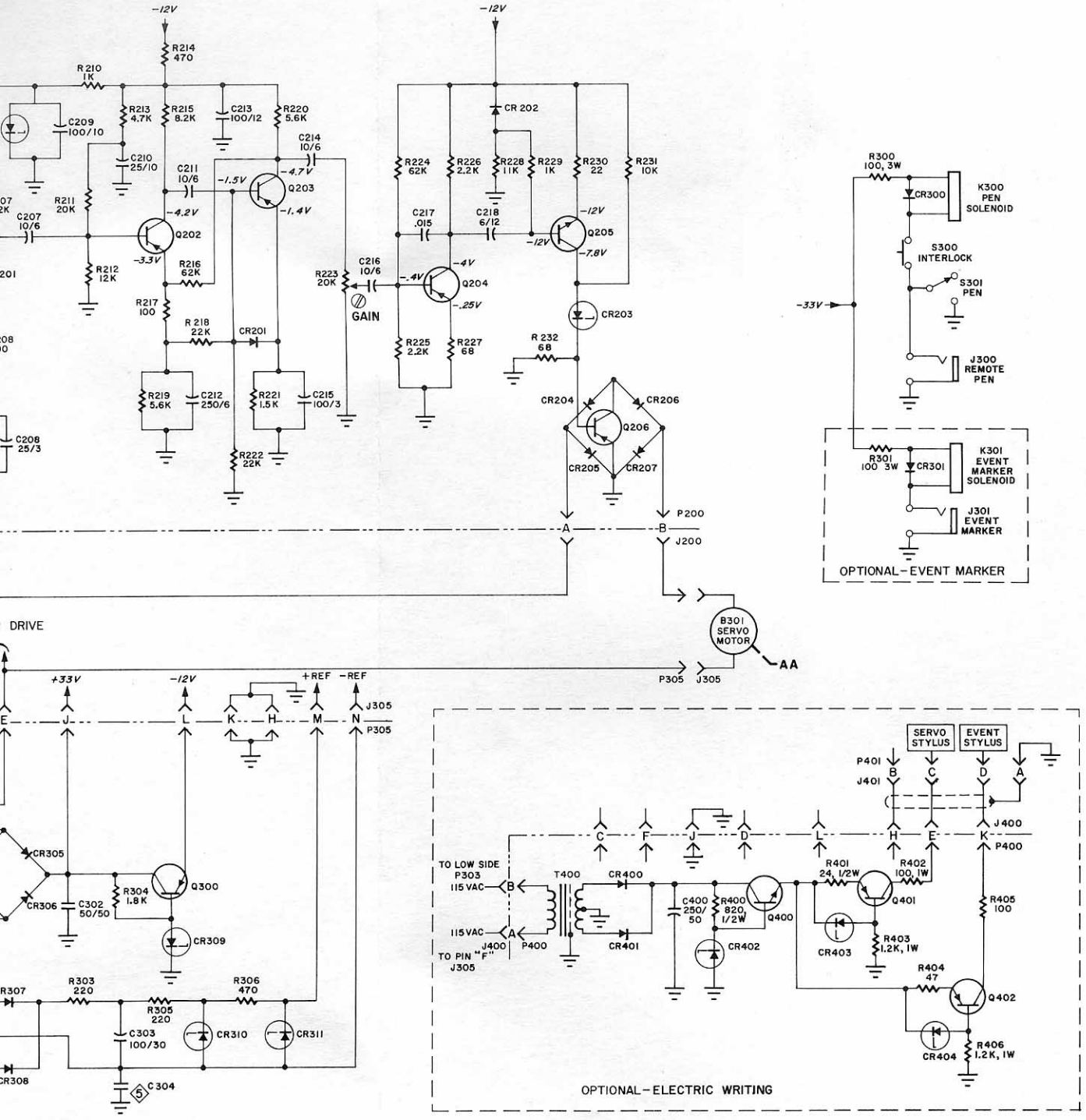
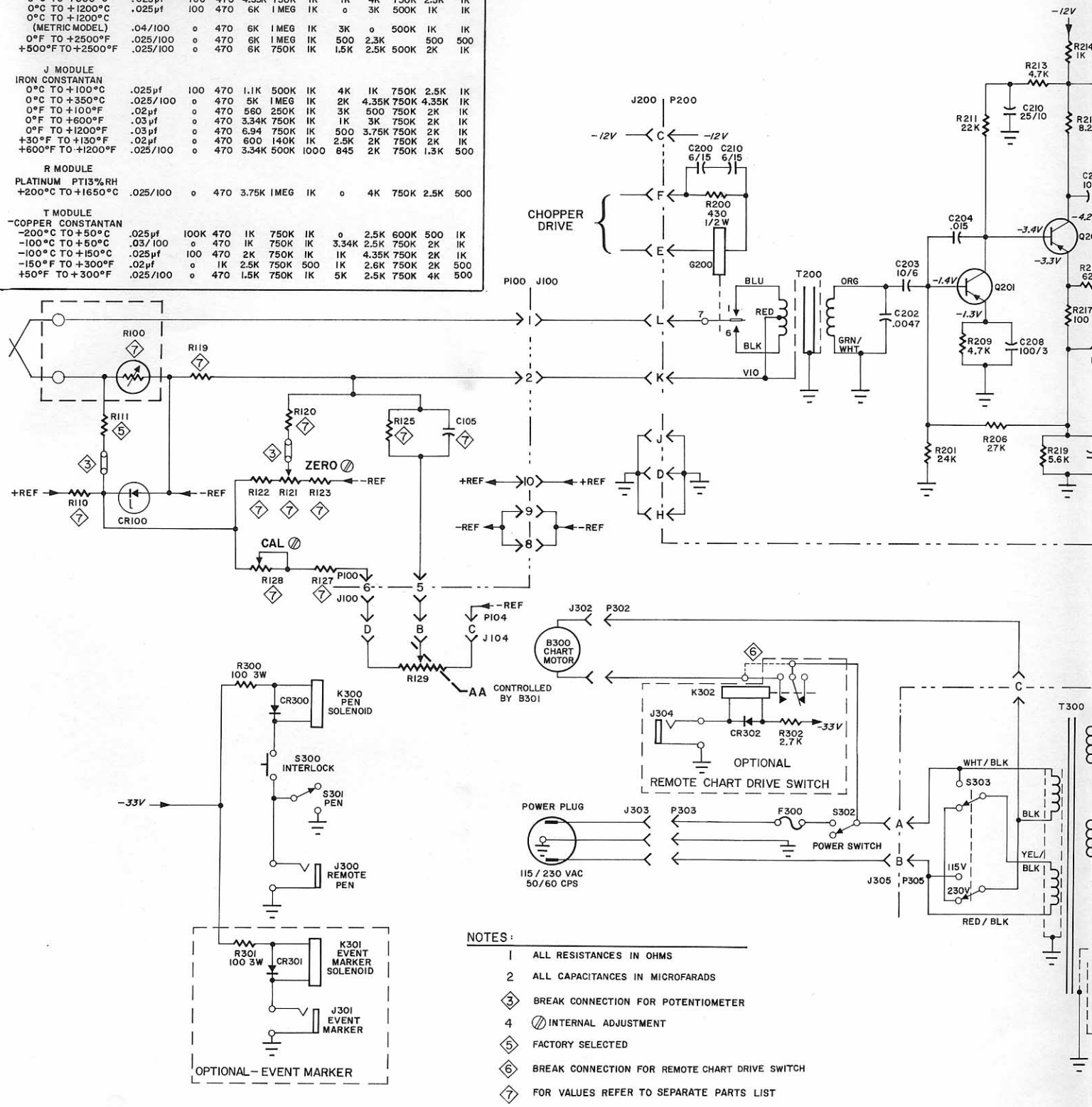


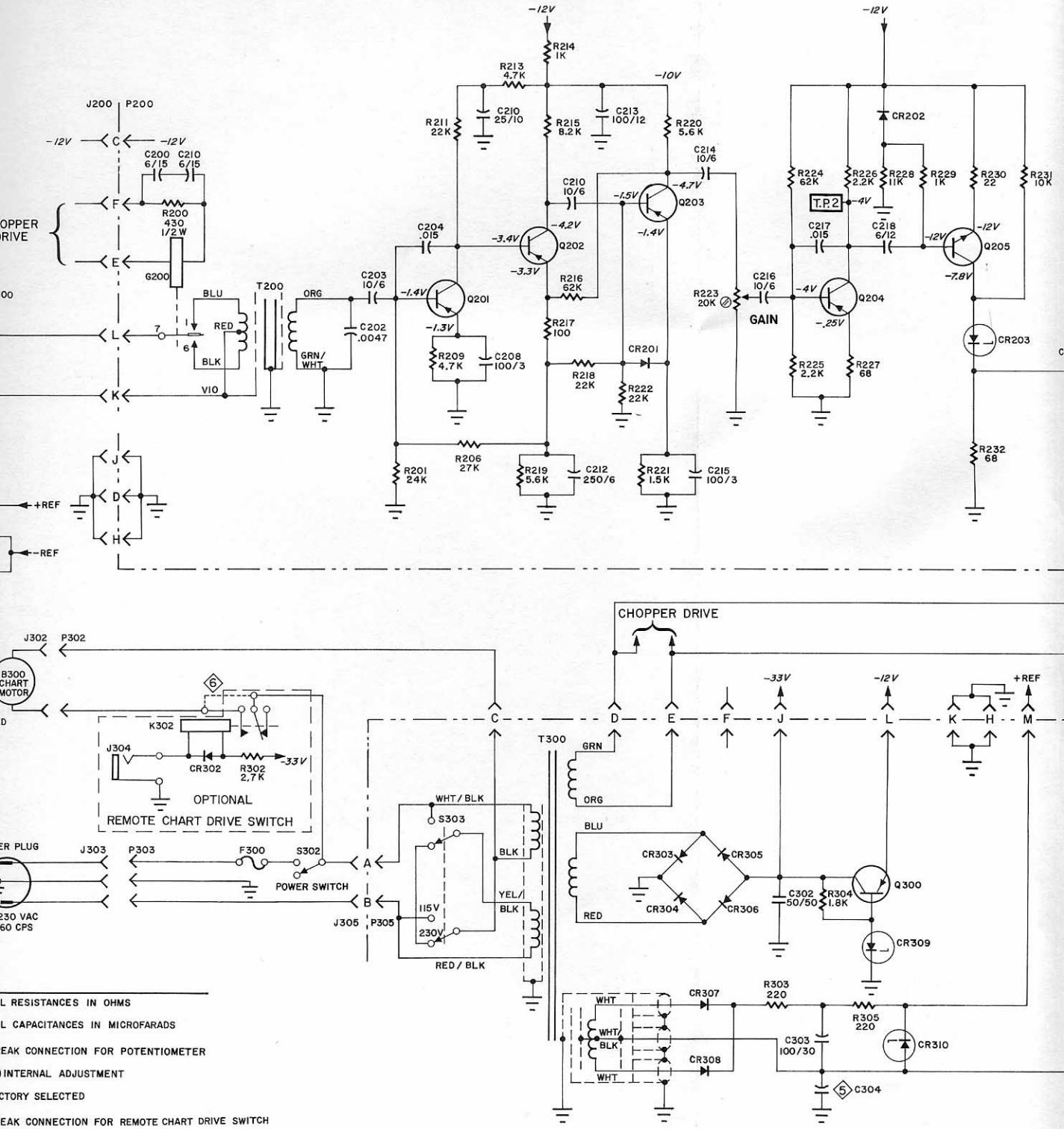
FIGURE 7-21. 681/17/681M-17
SCHEMATIC D5950-7321

K MODULE CHROMEL-ALUMEL	C105	R100	R110	R119	R120	R121	R122	R123	R125	R127	R128
−20°C TO +1200°C	.025/100	0	470	6K	1 MEG	1K	500	3K	500K	1.5K	500
0°C TO +500°C	.025μf	100	470	4.35K	750K	1K	1K	4K	750K	2.5K	1K
0°C TO +1200°C	.025μf	100	470	6K	1 MEG	1K	0	3K	500K	1K	1K
0°C TO +1200°C (METRIC MODEL)	.04/100	0	470	6K	1 MEG	1K	3K	0	500K	1K	1K
0°F TO +2500°F	.025/100	0	470	6K	1 MEG	1K	500	2.3K		500	500
+500°F TO +2500°F	.025/100	0	470	6K	750K	1K	1.5K	2.5K	500K	2K	1K
J MODULE											
IRON CONSTANTAN											
0°C TO +100°C	.025μf	100	470	1.1K	500K	1K	4K	1K	750K	2.5K	1K
0°C TO +350°C	.025/100	0	470	5K	1 MEG	1K	2K	4.35K	750K	4.35K	1K
0°F TO +100°F	.02μf	0	470	560	250K	1K	3K	500	750K	2K	1K
0°F TO +600°F	.03μf	0	470	3.34K	750K	1K	1K	3K	750K	2K	1K
0°F TO +1200°F	.03μf	0	470	6.94	750K	1K	500	3.75K	750K	2K	1K
+30°F TO +130°F	.02μf	0	470	600	140K	1K	2.5K	2K	750K	2K	1K
+600°F TO +1200°F	.025/100	0	470	3.34K	500K	1000	845	2K	750K	1.3K	500
R MODULE											
PLATINUM PT13%RH											
+200°C TO +1650°C	.025/100	0	470	3.75K	1 MEG	1K	0	4K	750K	2.5K	500
T MODULE											
−COPPER CONSTANTAN											
−200°C TO +50°C	.025μf	100K	470	1K	750K	1K	0	2.5K	600K	500	1K
−100°C TO +50°C	.03/100	0	470	1K	750K	1K	3.34K	2.5K	750K	2K	1K
−100°C TO +150°C	.025μf	100	470	2K	750K	1K	1K	4.35K	750K	2K	1K
−150°F TO +300°F	.02μf	0	1K	2.5K	750K	500	1K	2.6K	750K	2K	500
+50°F TO +300°F	.025/100	0	470	1.5K	750K	1K	5K	2.5K	750K	4K	500



NOTES:

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. BREAK CONNECTION FOR POTENTIOMETER
4. INTERNAL ADJUSTMENT
5. FACTORY SELECTED
6. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
7. FOR VALUES REFER TO SEPARATE PARTS LIST



L RESISTANCES IN OHMS

L CAPACITANCES IN MICROFARADS

EAK CONNECTION FOR POTENTIOMETER

INTERNAL ADJUSTMENT

CTORY SELECTED

EAK CONNECTION FOR REMOTE CHART DRIVE SWITCH

R VALUES REFER TO SEPARATE PARTS LIST

FIGURE 7-22

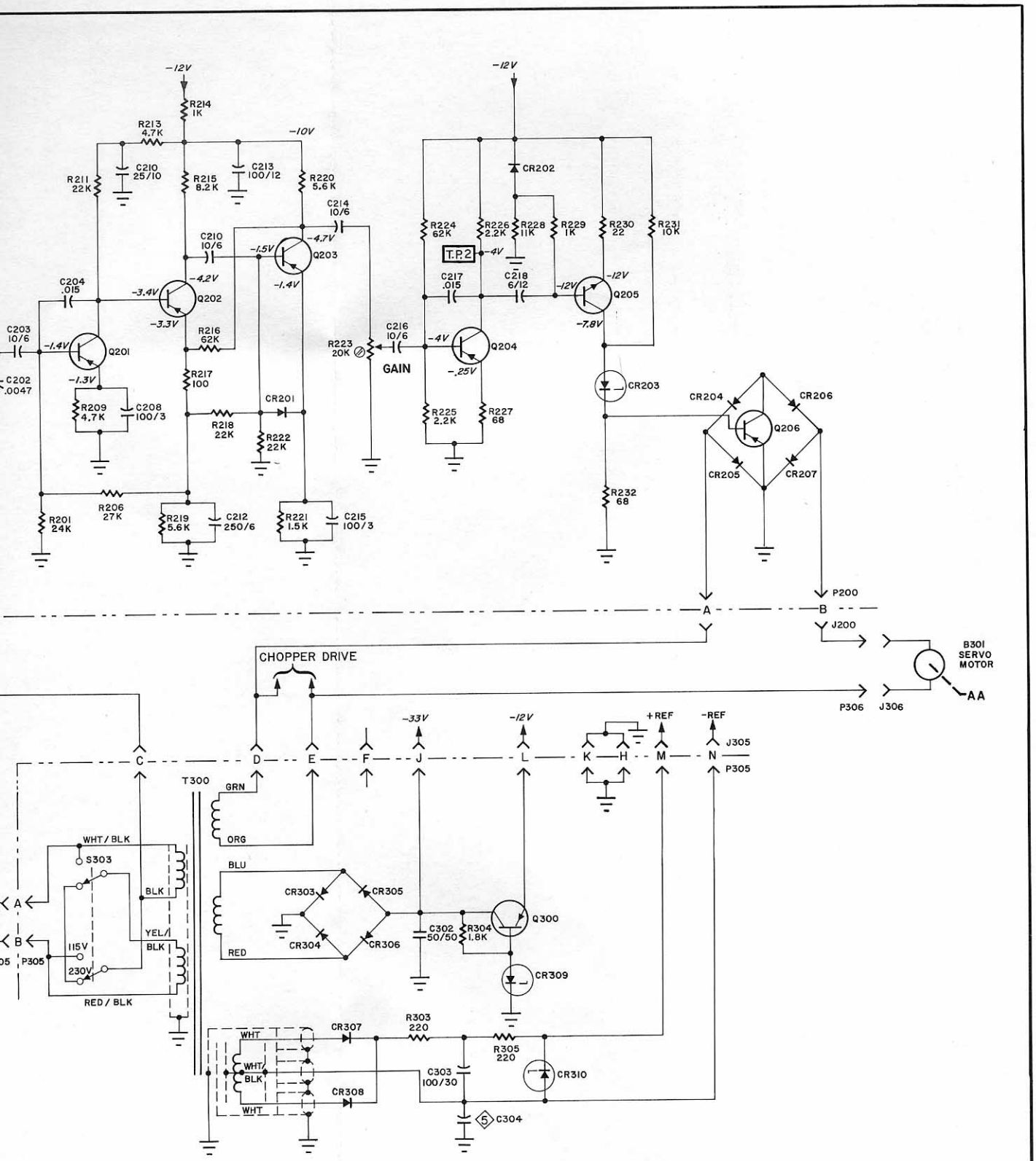
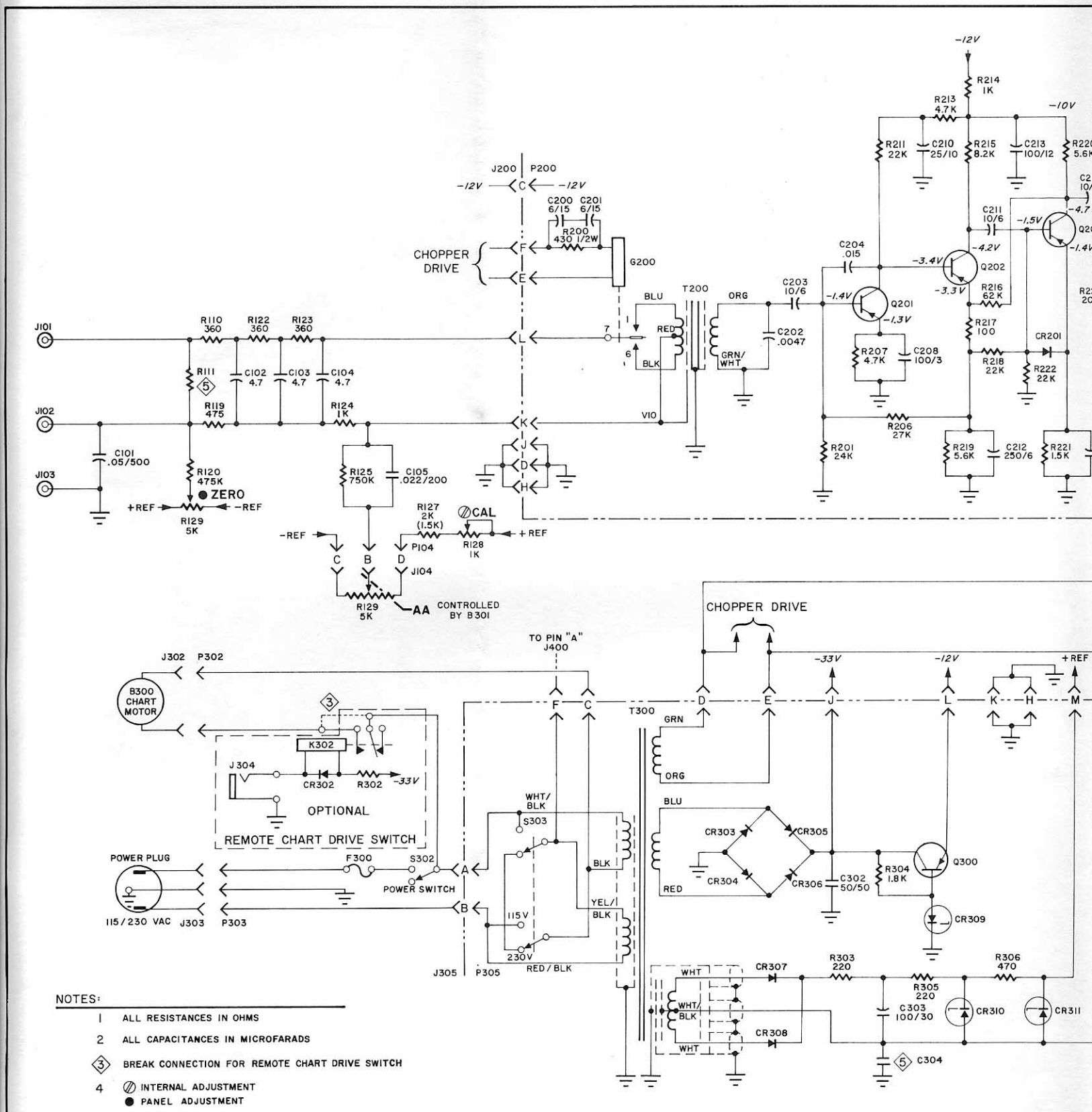


FIGURE 7-22. 682/682M SCHEMATIC D5950-7318



NOTES:

1. ALL RESISTANCES IN OHMS
2. ALL CAPACITANCES IN MICROFARADS
3. BREAK CONNECTION FOR REMOTE CHART DRIVE SWITCH
4. ⊘ INTERNAL ADJUSTMENT
   ● PANEL ADJUSTMENT
5. FACTORY SELECTED

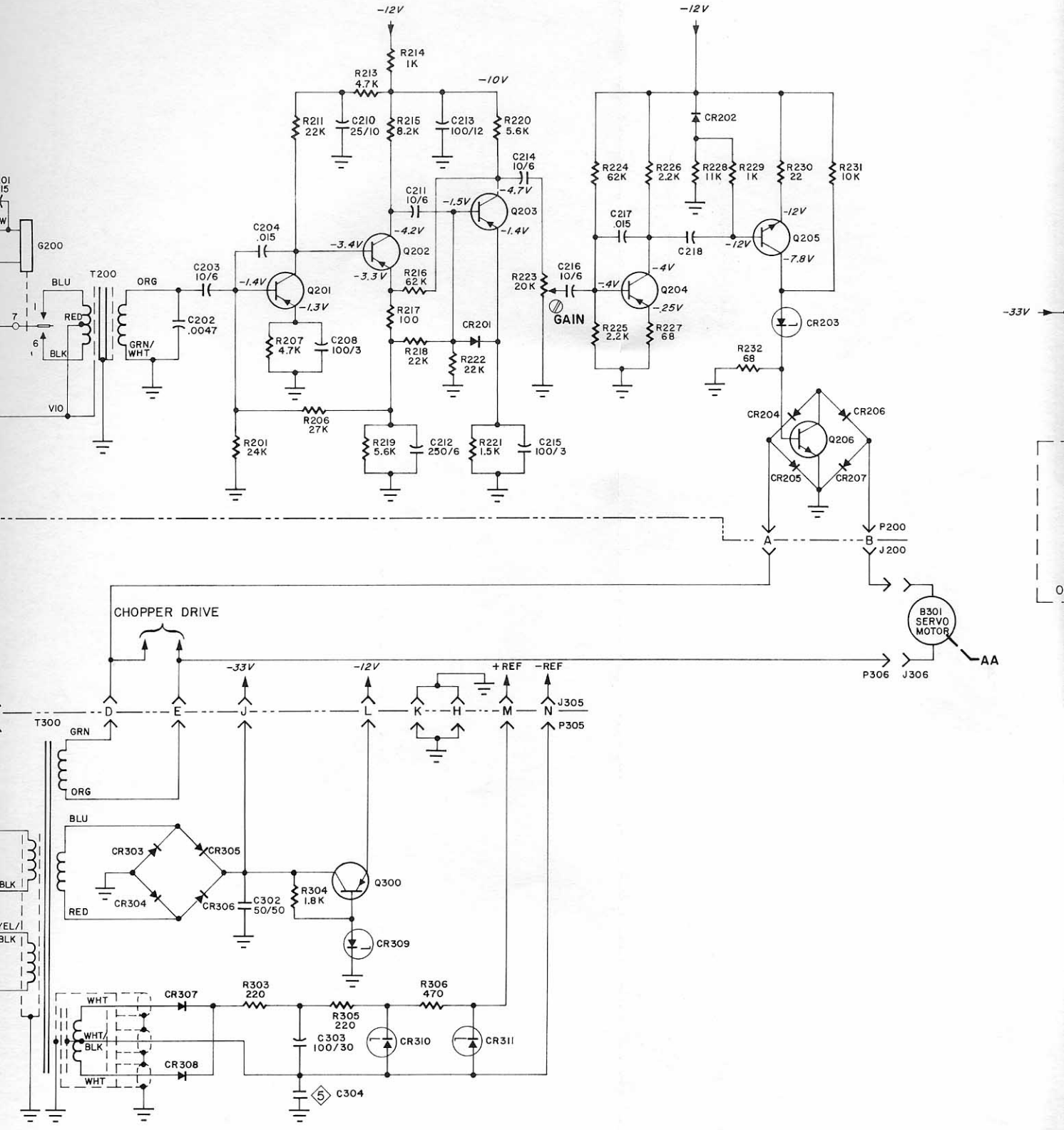


FIGURE 7-23. 683/683M

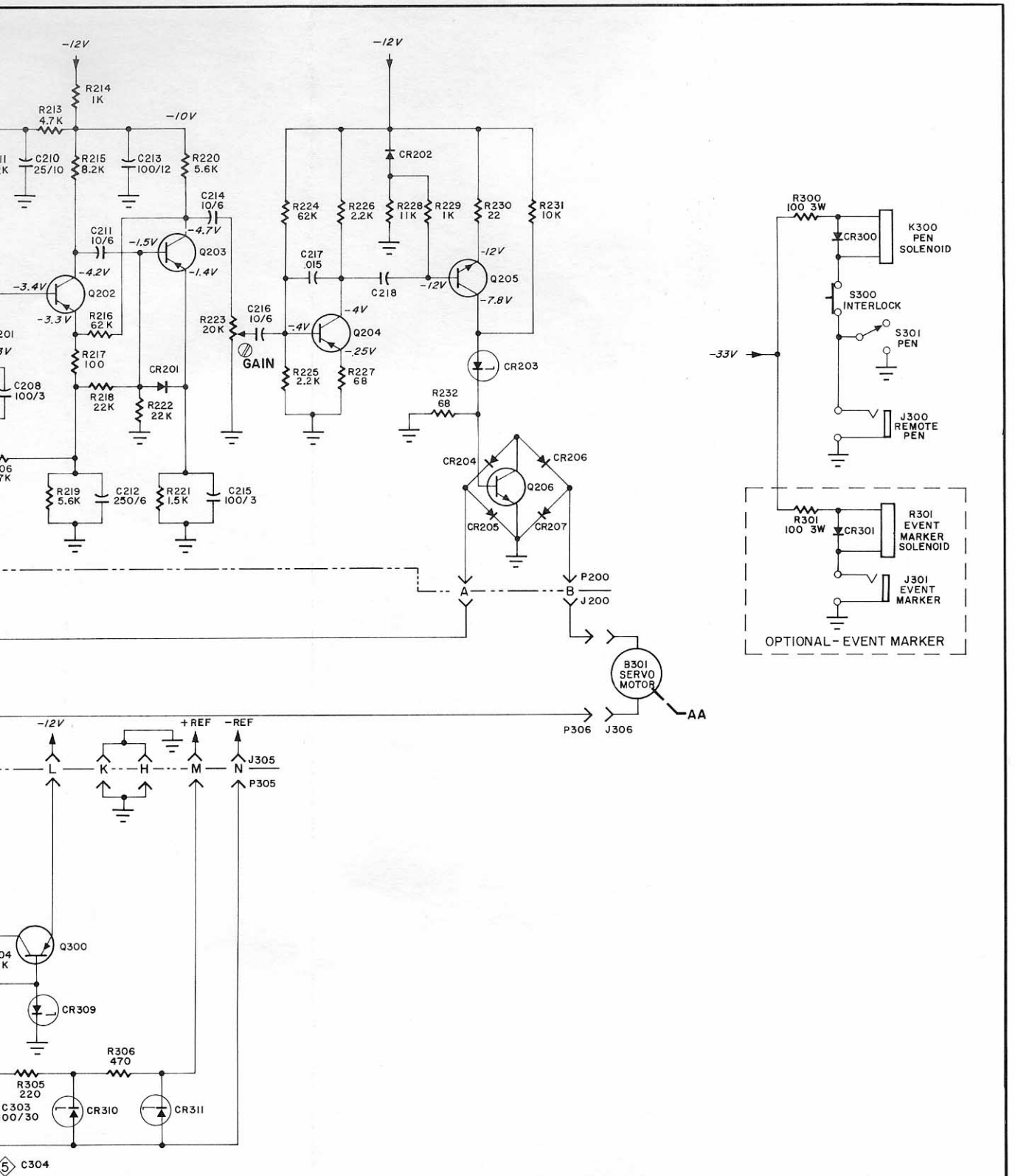


FIGURE 7-23. 683/683M SCHEMATIC D5950-7319